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SOME RESULTS OF PRACTICE IN ADDITION UNDER SCHOOL CONDITIONS.

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One hundred and ninety-two pupils—42 in the 7th grade, 54 in the 6th, 53 in the 5th, and 43 in the 4th—took part in this experiment, which consisted in adding columns, each of ten one-place numbers, as rapidly as was consistent with accuracy. Each child was led to compete with his own past record—was told repeatedly "to beat himself." Seven different sheets, each sheet containing forty-eight columns of equal difficulty, were used.

With the exception of certain groups, used as controls and called 'the control group', each pupil took an initial test of 15 minutes, 90 minutes of practice divided into periods of 5, 7½, 10, 11¼, 15, 20 or 22½ minutes, and a final test of 15 minutes.

The 'control groups' consisted of pupils who took the initial and final tests, without having any of the intervening practice.

*Mr. Hahn is responsible for the original measurements and their scoring; Mr. Thorndike is responsible for the further tabulations and computations of amount, rate, change of rate of improvement and the like, and for the inferences drawn therefrom. It is hoped that Mr. Hahn, who is doubtful concerning the methods of penalizing for errors and concerning some of the inferences, will add to the present discussion at a later date. The plan of the study was suggested by a similar but more extended study by Mr. T. H. Kirby, published as No. 58 of the Teachers College, Columbia University, Contributions to Education.

The scores of only those individuals who were present so as to get all or almost all** the practice are considered in what follows.

The time schedule of the entire experiment is given below, the numbers denoting the minutes of practice.

TIME SCHEDULE

Groups with Practice

		7A	7B	6A	6B	5A	5B	4A	4B
Oct.	15	15	15	15	15	15	15	15	15
"	16	22½	11¼	20	10	15	7½	10	5
"	17	22½	11¼	20	10	15	7½	10	5
"	18	22½	11¼	20	10	15	7½	10	5
"	19								
"	20								
"	21	22½	11¼	20	10	15	7½	10	5
"	22		11¼	20	10	15	7½	10	5
"	23		11¼		10	15	7½	10	5
"	24		11¼		10		7½	10	5
"	25		11¼		10		7½	10	5
"	26								
"	27								
"	28				10		7½	10	5
"	29	15	15	15	15		7½		5
"	30						7½		5
"	31						7½		5
Nov.	1					15	15	15	5
"	2								
"	3								
"	4								5
"	5								5
"	6								5
"	7								5
"	8								5
"	9								
"	10								
"	11								15

Control Groups

		7 (A and B)	6 (A and B)	5 (A and B)	4 (A and B)
Oct.	15	15	15	15	15
"	29	15	15		15
Nov.	1			15	

It should be kept in mind throughout the reading of what follows that any child was free to write out sums and practice with them at home, during the course of the experiment. The experiment was primarily an educational one, and no attempts were made to prevent practice apart from the specified prac-

**Where a pupil was absent say for only one five-minute period, his score for that period was estimated and included. There were only three such irregular records.

tice in school. We shall for simplicity's sake describe the results without suggesting in the case of any topic what changes, if any, would probably appear if the out-of-school practice could be detected and its effect subtracted from the gross obtained fact.

The scores in the initial and final tests for each pupil (save those who were absent during some period of the experiment) are given in Table 1. The full scores for individuals for the work of every practice period are not presented here, but various features of them will be reported. The children in the 4B group were included in the experiment without special intention of using the results from them, since they had not formed the fundamental associations required well enough to be proper subjects for such an experiment. Their records are reported here, but will be used with due regard to the fact just stated.

The results of the experiment are significant with respect to (1) the amount of improvement, (2) the rate of improvement, (3) changes in the rate during the course of the practice, (4) the effect of period-length upon the rate of improvement, (5) individual differences in initial efficiency, (6) individual differences in rate of improvement, (7) the relation of rate of improvement to initial ability. The facts relevant to each of these topics will be presented in order.

The Amount and Rate of Improvement

The amount of improvement is great, as is roughly seen by mere inspection of Table 1. To estimate it more precisely, some method of equating the amount of adding done per unit of time with its accuracy is necessary. In the present article, two methods of equating will be used. One is very severe toward inaccuracy, no credit whatever being given for any example with a wrong answer. This means that unless the pupil made all the nine additions which an example required without error, he got no advantage in his score from them.* By the other method, half credit is given for a wrong answer. The reader may figure out the improvement by any other scheme of equating, if it seems desirable.

*Except when by chance his errors within one example exactly compensated.

TABLE 1. IMPROVEMENT IN ADDITION.

Initial Score, Final Score, and Change for each Individual.

Grade 7A. 22½ min. Periods.

	Initial Test		Final Test		Change	
Ind.	R	W	R	W	R	W
1	22	19	42	14	20	—5
2	21	20	73	5	52	—15
3	38	6	57	7	19	1
4	35	10	53	4	18	—6
5	28	8	56	8	28	0
6	27	11	55	11	28	0
7	31	8	42	15	11	7
8	28	8	48	2	20	—6
9	28	9	51	6	23	—3
10	27	14	36	15	9	1

Grade 7B. 11¼ min. Periods.

11	23	3	31	9	8	6
12	20	16	42	13	22	—3
13	11	13	40	11	29	—2
14	32	16	49	12	17	—4
15	23	25	31	21	8	—4
16	26	15	56	13	30	—2
17	31	6	43	7	12	1
18	20	14	44	21	24	7
19	13	24	37	36	24	12
20	33	14	57	12	24	—2
21	23	10	29	12	6	2
22	9	10	10	24	1	14
23	22	12	47	10	25	—2
24	14	12	25	8	11	—4
25	22	20	41	27	19	7
26	25	21	51	20	26	—1

Grade 7. Control Group.

27	20	21	28	14	8	—7
28	21	22	46	6	25	—16
29	21	13	28	10	7	—3
30	24	10	32	2	8	—8
31	25	5	23	11	—2	6
32	8	8	20	6	12	—2
33	36	5	40	7	4	2
34	25	5	27	4	2	—1
36	32	5	43	2	11	—3

Grade 6A. 20 min. Periods.

	Initial Test		Final Test		Change	
Ind.	R	W	R	W	R	W
37	17	15	19	14	2	—1
38	24	5	31	1	7	—4
39	22	2	36	4	14	2
40	32	10	40	11	8	1
41	11	10	28	10	17	0
42	19	14	29	17	10	3
43	13	6	13	18	0	12
44	16	4	34	5	18	1
45	28	7	30	11	2	4
46	12	19	44	5	32	—14
47	20	13	23	11	3	—2
48	11	14	0	49	—11	35
49	9	7	38	7	29	0
50	22	17	29	10	7	—7

Grade 6B. 10 min. Periods.

51	12	5	6	39	—6	34
52	16	11	23	18	7	7
53	26	6	27	15	1	9
54	13	11	44	22	31	11
55	4	11	20	13	16	2
56	7	11	13	16	6	5
57	12	13	18	13	6	0
58	12	10	20	23	8	13
59	34	14	43	18	9	4
60	4	12	6	13	2	1
61	17	10	33	8	16	—2
62	22	5	47	9	25	4
63	10	10	20	10	10	0

Grade 6. Control Group.

64	25	9	35	1	10	—8
65	26	5	34	1	8	—4
66	5	14	14	12	9	—2
67	19	13	19	12	0	—1
68	24	5	31	5	7	0
69	14	14	20	11	6	—3
71	1	15	6	14	5	—1
72	26	15	26	12	0	—3
73	9	9	12	8	3	—1
74	16	7	19	8	3	1
75	20	16	26	9	6	—7
76	3	5	5	8	2	3
77	16	12	19	9	3	—3
78	17	5	15	8	—2	3
79	19	10	24	6	6	—4

Table 1 (Continued)

Grade 5A. 15 *min. Periods.*

Ind.	Initial Test R	Initial Test W	Final Test R	Final Test W	Change R	Change W
80	27	22	30	48	3	26
81	9	9	26	8	17	—1
82	9	4	40	2	31	—2
83	10	2	6	13	—4	11
84	22	8	41	6	19	—2
85	5	10	14	11	9	1
86	20	4	13	35	—7	31
87	19	5	32	7	13	2
88	24	13	41	14	17	1
89	9	7	15	4	6	—3
90	25	11	57	6	32	—5
91	15	1	30	15	5	14
92	4	4	24	28	20	24
93	15	3	23	18	8	15
94	13	4	16	17	3	13
95	27	9	45	24	18	15
96	12	12	18	16	6	4
97	12	12	29	9	17	—3
98	33	12	87	4	54	—8
99	29	9	25	27	—4	18
100	3	8	11	37	8	29
101	5	9	15	17	10	8
102	10	9	23	13	13	4

Grade 5B. 7½ *min. Periods.*

103	16	5	20	22	4	17
104	4	12	31	24	27	12
105	17	7	21	12	4	5
106	21	6	30	25	9	19
107	11	16	12	51	1	35
108	16	9	22	14	6	5
109	12	9	23	11	11	2
110	18	10	18	41	0	31
111	11	4	28	32	17	28
112	2	10	3	8	1	—2
113	21	6	39	6	18	0
114	3	7	3	21	0	14
115	11	13	3	41	—8	28
116	15	9	43	14	28	5
117	9	18	18	26	9	8

Grade 5. Control Group.

118	10	15	10	18	0	3
119	9	19	4	19	—5	0
120	9	7	9	8	0	1
121	16	6	14	2	—2	—4
122	24	7	21	9	—3	2
123	9	24	16	21	7	7
124	24	13	25	15	1	2
125	14	6	12	9	—2	3
126	12	6	18	11	6	5
127	15	9	9	14	—6	5
128	9	2	14	0	5	—2

Grade 4A. 10 *min. Periods.*

Ind.	Initial Test R	Initial Test W	Final Test R	Final Test W	Change R	Change W
129	16	2	47	30	31	28
130	3	15	21	20	18	5
131	6	12	28	12	18	0
132	12	3	25	8	13	5
133	8	4	21	17	13	13
134	9	10	23	9	14	—1
135	7	4	19	12	12	8
136	3	6	18	11	15	5
137	15	3	34	14	19	11
138	12	3	25	6	13	3
139	4	8	12	7	8	—1
140	12	3	26	5	14	2
141	6	15	19	13	13	—2
142	4	8	16	11	12	3
143	16	6	32	11	16	5
144	18	8	36	17	18	9
145	4	6	9	9	5	3

Grade 4B. 5 *min. Periods.*

146	13	9	16	11	3	2
147	3	7	11	7	8	0
148	8	13	7	21	—1	7
149	2	6	25	7	23	1
150	0	12	3	39	3	27
151	12	7	8	28	—4	21
152	7	7	1	11	—6	4

Grade 4. Control Group.

153	15	16	15	12	0	—4
154	3	5	7	4	4	—1
155	0	9	2	5	2	—4
156	12	6	15	8	3	2
157	12	18	14	11	2	—7
158	9	2	5	8	—4	6
159	15	12	18	9	3	—3
160	7	12	16	8	9	—4
161	16	9	28	3	12	—6
162	9	15	9	16	0	1
163	10	5	19	5	9	0
164	4	11	9	8	5	—3
165	2	12	11	5	9	—7
166	22	9	34	8	12	—1
167	13	5	12	12	—1	7

Using the first method of scoring, we have, as the average gain for each group:

7A	22½	min.	periods	22.8	examples	right	on	an	initial	28.5	examples	right
7B	11¼	"	"	17.3	"	"	"	"	"	21.7	"	"
7	only the two tests			6.4	"	"	"	"	"	23.8	"	"
6A	20	min.	periods	9.8	"	"	"	"	"	18.3	"	"
6B	10	"	"	10.1	"	"	"	"	"	14.5	"	"
6	only the two tests			4.4	"	"	"	"	"	15.8	"	"
5A	15	min.	periods	13.6	"	"	"	"	"	15.7	"	"
5B	7½	"	"	8.4	"	"	"	"	"	12.5	"	"
5	only the two tests			0.1	"	"	"	"	"	13.7	"	"
4A	10	min.	periods	15.1	"	"	"	"	"	9.1	"	"
4B	5	"	"	3.7	"	"	"	"	"	6.4	"	"
4	only the two tests			4.3	"	"	"	"	"	9.9	"	"

As the median gains for the different groups, we have:—

7A	22½	min.	periods	20	examples	right	on	an	initial	25	examples	right
7B	11¼	"	"	20½	"	"	"	"	"	21	"	"
7	only the two tests			7½	"	"	"	"	"	21	"	"
6	only the two tests			7½	"	"	"	"	"	24	"	"
6A	20	min.	periods	8	"	"	"	"	"	12	"	"
6B	10	"	"	5	"	"	"	"	"	6½	"	"
5A	15	min.	periods	10	"	"	"	"	"	15	"	"
5B	7½	"	"	6	"	"	"	"	"	16	"	"
5	only the two tests			0	"	"	"	"	"	9½	"	"
4A	10	min.	periods	15	"	"	"	"	"	15	"	"
4B				3	"	"	"	"	"	6½	"	"
4	only the two tests			3	"	"	"	"	"	13½	"	"

On the whole, the pupils who had the special practice gained about 80 per cent in the number of examples correct.

If we compute the gains according to initial status, we find that:

Pupils	scoring	0— 6	in	the	initial	test	gained,	on	the	average,	11.4
"	"	7—12	"	"	"	"	"	"	"	"	9.2
"	"	13—18	"	"	"	"	"	"	"	"	11.3
"	"	19—24	"	"	"	"	"	"	"	"	14.2
"	"	25—30	"	"	"	"	"	"	"	"	18.0
"	"	31—36	"	"	"	"	"	"	"	"	19.1

By the second method of scoring, with half credit for each wrong answer, the average gains for the different groups were as follows:

7A	22½	min.	periods	21.5	on an	initial	score of	34.2
7B	11¼	"	"	18.6	" "	"	" "	28.9
7	only the two tests			5.2	" "	"	" "	29.0
6A	20	min.	periods	10.8	" "	"	" "	23.5
6B	10	"	"	13.5	" "	"	" "	19.5
6	only the two tests			3.5	" "	"	" "	20.7
5A	15	min.	periods	17.6	" "	"	" "	19.9
5B	7½	"	"	15.2	" "	"	" "	17.3
5	only the two tests			1.1	" "	"	" "	18.9
4A	10	min.	periods	17.9	" "	"	" "	12.5
4B	5	"	"	8.7	" "	"	" "	10.8
4	only the two tests			3.5	" "	"	" "	14.8

This great gain from practice under school conditions is in accord with the expectations from the results obtained in the case of adults by Thorndike and by Wells, and with the results obtained from school children by Kirby and by Donovan and Thorndike. It seems therefore safe to say that school pupils, taken as they are found, will gain nearly one per cent a minute in amount done correctly from an hour's distributed practice in adding, and will maintain or improve the percentage of correct answers in their total product. Properly administered speed drills will in fact improve accuracy as well.

Changes in the Rate of Improvement

There are notable changes in the rate of improvement, this being defined as the gross gain in score per unit of time. The first half of the practice is the more productive. This is seen in the practice curves for each group taken as a total, which are shown in Figs. 1-8. It is still more easily seen by combining all the records for all individuals who practiced for the 120 minutes.* The results, so combined, for grades 6 and 7 are shown in Fig. 9; and for grades 4 and 5 in Fig. 10.

If each grade is given equal weight in determining the result, regardless of the number of individuals or the gross size of their scores, by putting the achievements of successive

*These combinations are made on the basis of eight 15-minute periods. For those practicing 15, 22½, 22½, etc., we have taken two thirds of the score of the first 22½-minute period as the score for the second 15-minute period; one third of the score of the first 22½ minute period plus one third of the score of the second 22½-minute period as the score for the third 15-minute period; and so on. Similar obvious computations are made for those practicing 15, 11¼, 11¼, etc.; and for those practicing 15, 10, 10, etc.

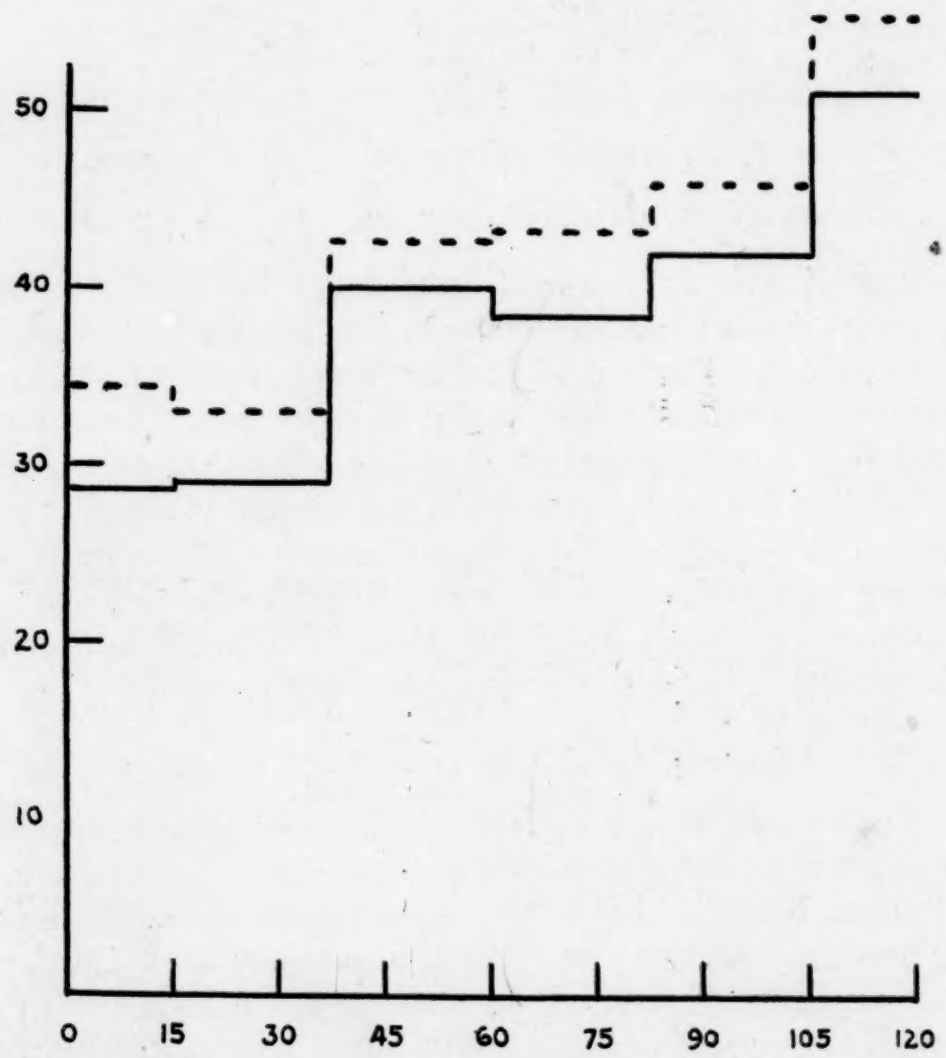

Fig. 1. Improvement in Adding: 7A. The horizontal scale is for minutes spent in practice; the vertical scale is for score made. The continuous line gives the number of correct answers per 5 minutes; the dash line gives the number correct plus half the number wrong.

periods in terms of percentages of the initial score, the results are as shown in Figs. 11 and 12.

In Figs. 1-12, the continuous line gives the results when the score used is the number of correct answers obtained in fifteen minutes; the dash line gives the results when the score used is the number of correct answers plus half the number of wrong answers.

For the negative acceleration that characterizes the entire group, a slackening of interest seems likely to have been the chief cause, since there is no question (save with a very few pupils) of approximation to the limit of efficiency in the function; and since the decreasing rate of improvement cannot be due to reaching a point where much 'harder' habits have to be formed to produce equal effects on the score.

The Influence of the Length of Practice Period upon Improvement

If the 'A' groups, practicing in double-length periods, are compared with the 'B' groups, using Figs. 1-10 as they stand, the A groups make the better showing. By the first method of scoring, the advantage of the long-period groups is 1.2 for grade 7, —1.4 (i. e., inferiority in gain) for grade 6, 6.2 for grade 5 and 4.3 for grade 4. By the second method of scoring, the corresponding figures are —.8, —3.7, 3.5 and 2.7. The comparison of the gains from long and from short practice-periods is however complicated by the fact that the A grade is in every case composed of a group superior in school tasks to the corresponding B grade. We are then comparing the effect of a long period on pupils who are more gifted (from the point of view of the school).

It would be possible to choose from the A and B groups in each grade pupils of equal ability in pairs, and compare the gains from long and short periods of the groups of equal initial ability thus constituted. But here again we run the risk of selecting gifted pupils who happen to be lower than their mates in addition and dull pupils who happen to be higher than their mates.

Probably the least objectionable form of this comparison is to leave out the best adders (in the initial test) from the A

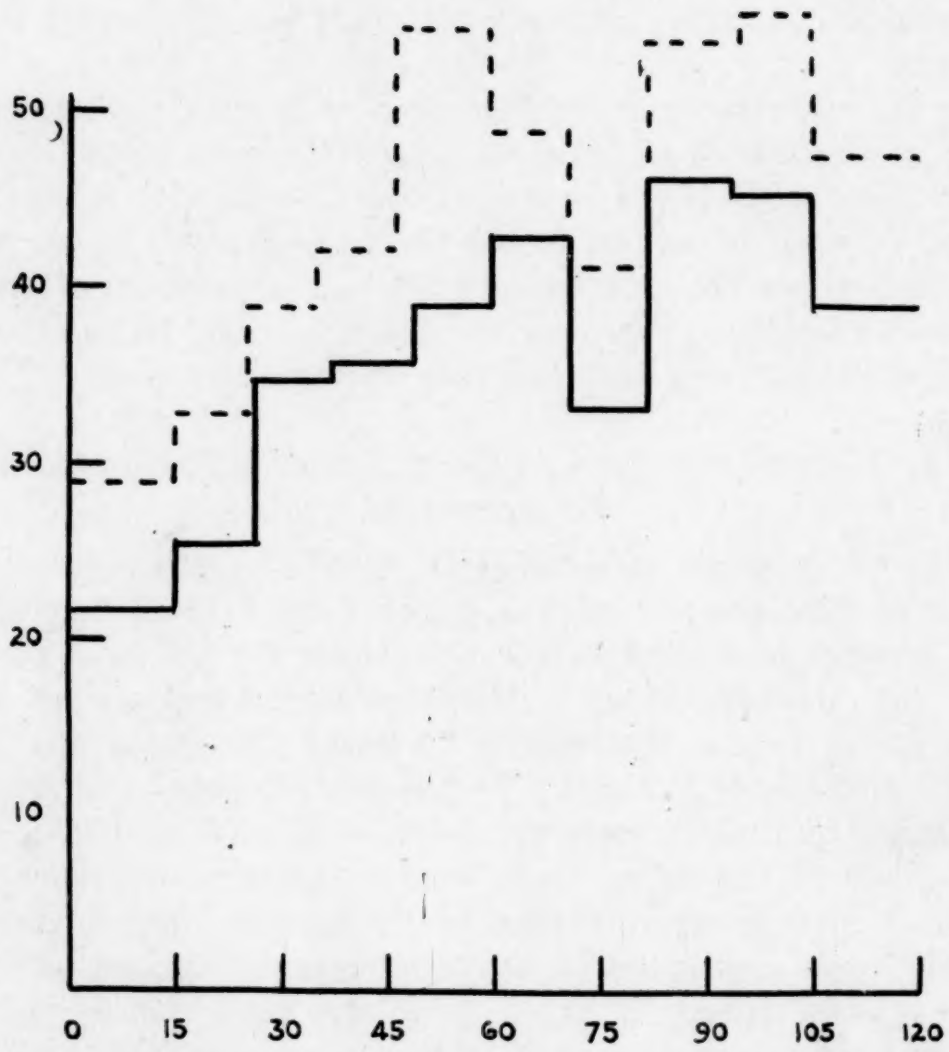

Fig. 2. Improvement in Adding: 7B. The horizontal scale is for minutes spent in practice; the vertical scale is for the score made. The continuous line gives the number of correct answers per 15 minutes; the dash line gives the number correct plus half the number wrong.

groups and the worst from the B groups until the groups as groups are approximately equal in initial status.

Doing so for the first method of scoring we have Table 2.

TABLE 2.

Long-period and Short-period Groups of Equal Initial Ability Compared, a Wrong Answer Counting 0.

Grade	Length of Period	Average Initial Score	Average Final Score	Gain	Advantage of the A Group
7A	22½	25.9	51.6	25.7	8.2
7B	11¼	26.0	43.5	17.5	
6A	20	16.3	27.0	10.7	.0
6B	10	17.4	28.1	10.7	
5A	15	13.5	24.9	11.4	1.4
5B	7½	14.8	24.8	10.0	
4A	10	7.5	21.1	13.6	9.8
4B	5	7.5	11.3	3.8	

There is further complication in that the long-period groups took the final test at dates further removed from their last period of special drill than did the short-period groups. This was of little or no advantage to them, however.

The method of scoring also makes a difference in the results of the comparison of long and short-period groups.

If we credit a correct example as 1 and an example done incorrectly as ½, we have, instead of Table 2, Table 3. The data whence both Table 2 and Table 3 are computed are given in Table 4 so that the facts for any other scheme of scoring may be conveniently computed.

TABLE 3.

Long-period and Short-period Groups of Equal Initial Ability Compared, a Wrong Answer Counting 0.5.

Grade	Length of Period	Average Initial Score	Average Final Score	Gain	Advantage of the A Group
7A	22½	32.2	56.0	23.8	6.2
7B	11¼	33.1	50.7	17.6	
6A	20	22.0	33.3	11.3	
6B	10	22.2	36.9	14.7	—3.4
5A	15	17.2	32.5	15.3	
5B	7½	19.5	37.1	17.6	—2.3
4A	10	11.1	26.6	15.5	7.0
4B	5	11.6	20.1	8.5	

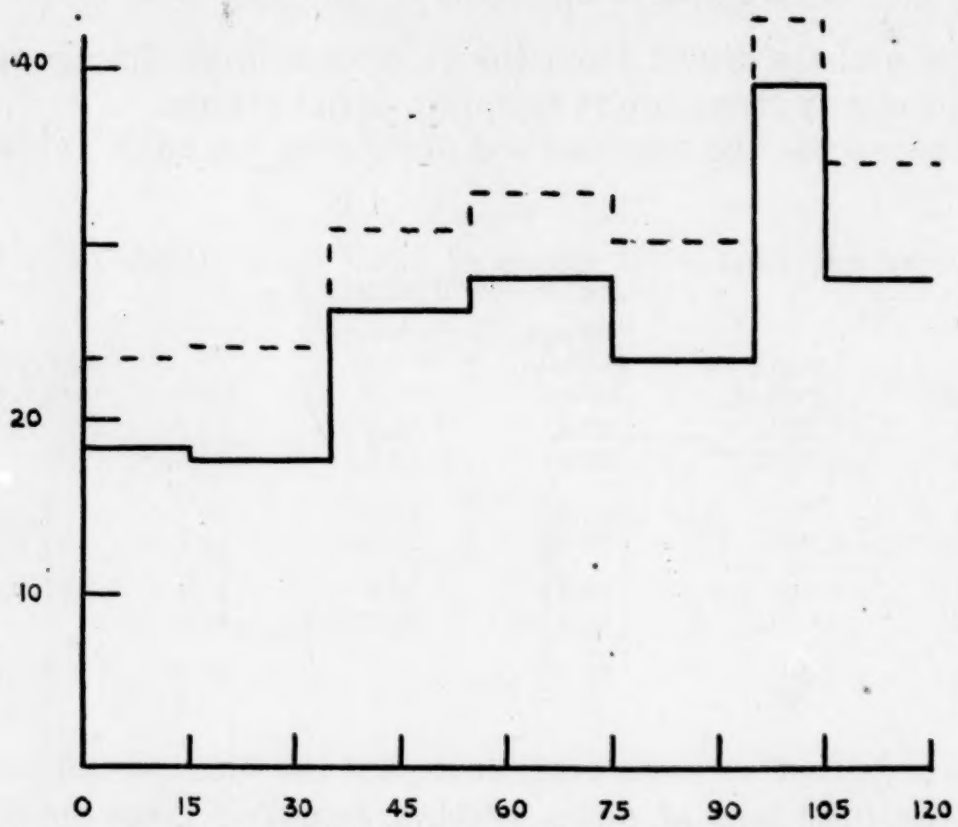

Fig. 3. Improvement in Adding: 6A. The horizontal scale is for minutes spent in practice; the vertical scale is for the score made. The continuous line gives the number of correct answers per 15 minutes; the dash line gives the number correct plus half the number wrong.

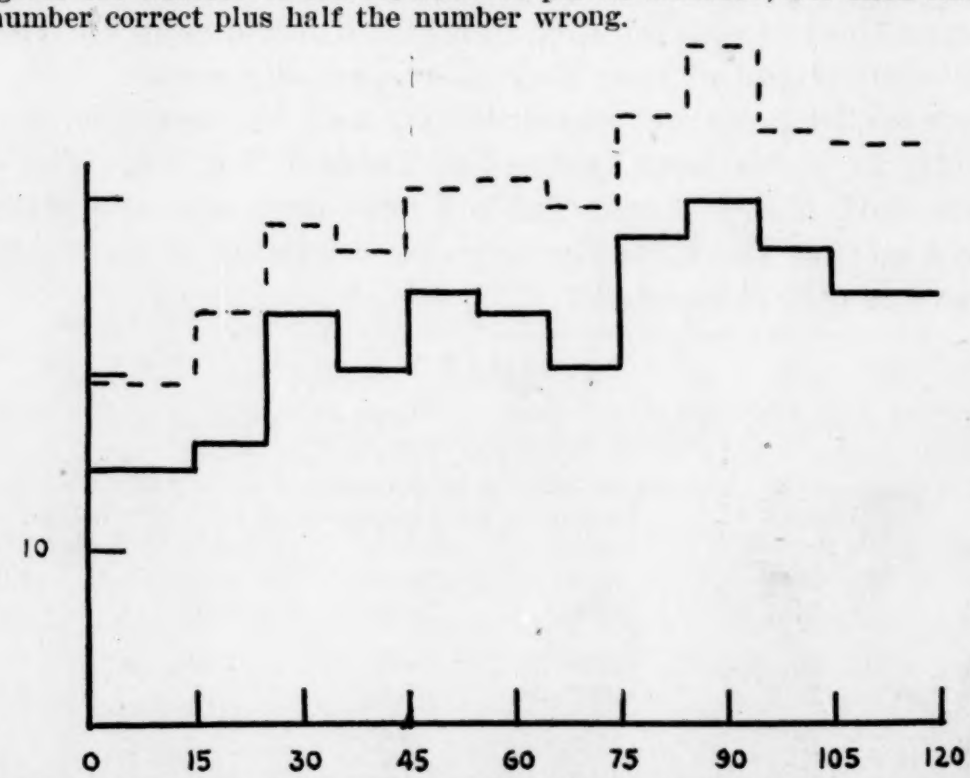

Fig. 4. Improvement in Adding: 6B. The horizontal scale is for minutes spent in practice; the vertical scale is for the score made. The continuous line gives the number of correct answers per 15 minutes; the dash line gives the number correct plus half the number wrong.

TABLE 4.

Grade	Form of Practice	Number of Pupils	Average Initial Score		Average Final Score		Increase in Number	
			R.	W.	R.	W.	R.	W.
7A	15, 22½ etc.	7	25.9	12.7	51.6	8.7	25.7	—4.9
7B	15, 11¼ "	10	26.0	14.2	43.5	14.3	17.5	+0.1
6A	15, 20 "	12	16.3	11.3	27.0	12.6	10.7	+1.3
6B	15, 10 "	10	17.4	9.5	28.1	17.5	10.7	+8.0
5A	15, 15 "	19	13.5	7.4	24.9	15.1	11.4	+7.7
5B	15, 7½ "	12	14.8	9.3	24.8	24.6	10.0	+5.3
4A	15, 10 "	14	7.5	7.1	21.1	11.0	13.6	+3.9
4B	15, 5 "	6	7.5	8.2	11.3	17.3	3.8	+9.3

In consideration of the facts stated on page 67 concerning the 4B group, the comparison of the 4A and 4B groups may well be left out of account. If this is done and the second method of scoring is used, the long-period and short-period groups appear to have made equal improvement.

On the whole we may safely say that in this experiment the short periods were certainly not much more favorable than the longer periods, the evidence, though not secure, being in favor of the longer periods.

In his similar investigation, Kirby found the gains (scored by Method 1) from practice in 22½-, 15-, 6- and 2-minute periods to stand in the relation 100, 121, 101 and 146½. The gains in his experiment held almost exactly the same relations when wrong answers were given credit, since the percentages of wrong answers were substantially the same at the beginning and at the end of the experiment for all groups.

Individual Differences in Initial Ability and in Amount of Gain

The wide range in initial ability of pupils of the same grade who have had approximately the same school training in adding is obvious from inspection of Table 1. In the seventh grade the range is from 8 right and 8 wrong to 38 right and 6 wrong. In the sixth, it is from 1 right and 15 wrong to 34 right and 14 wrong. The distributions for all grades are shown in Table 5. Part of the variation in each grade is due to temporary causes which make the test of 15 minutes give too low or too high a measure of an individual's ability. Also if

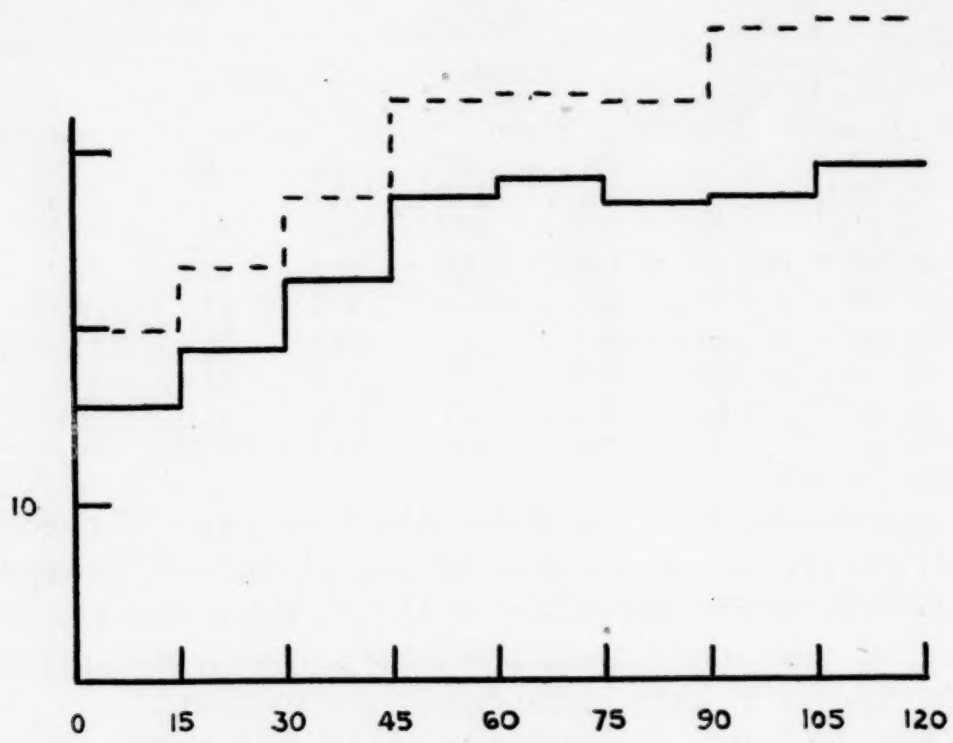

Fig. 5. Improvement in Adding: 5A. The horizontal scale is for minutes spent in practice; the vertical scale is for the score made. The continuous line gives the number of correct answers per 15 minutes; the dash line gives the number correct plus half the number wrong.

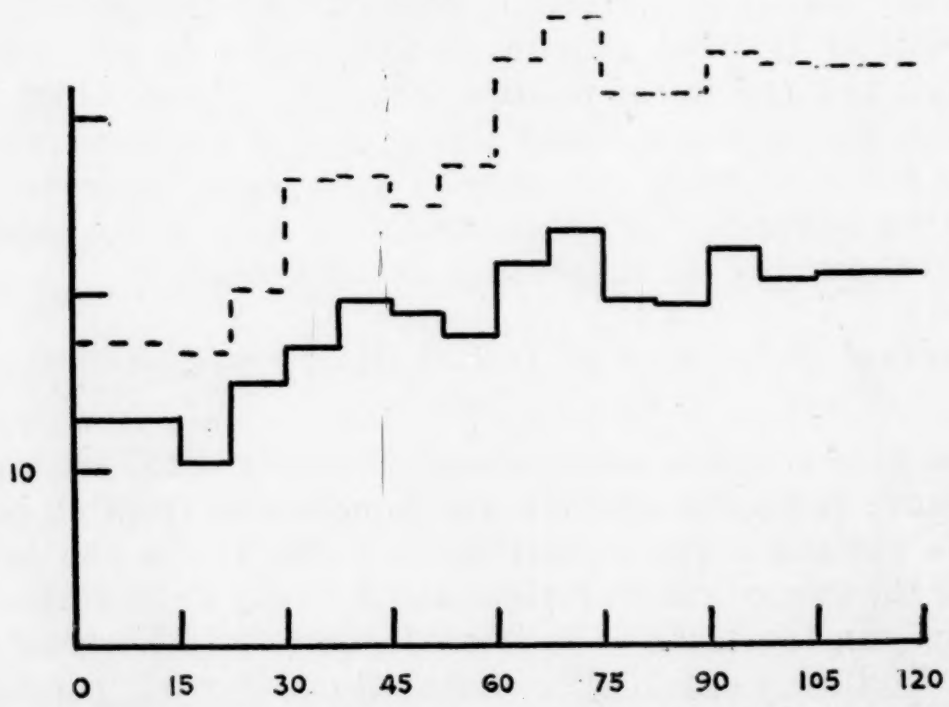

Fig. 6. Improvement in Adding: 5B. The horizontal scale is for minutes spent in practice; the vertical scale is for the score made. The continuous line gives the number of correct answers per 15 minutes; the dash line gives the number correct plus half the number wrong.

'total amount done' had been used as a measure the percentile variability would have been reduced somewhat. But with any number of tests and any rational scheme of scoring, the variations would still be enormous. The table shows clearly the enormous overlapping of the different grades in respect to ability in adding at the start of the experiment.

The wide range in the gross gain of pupils of the same grade is also obvious upon inspection of Table 1. The facts are shown in detail in Table 6. If freed from temporary special influence upon the initial and final tests the variations would be reduced somewhat; and if the gain in 'total amount done' is computed, it is found to show less percentile variation, but still by any count the differences of individuals in improvement from 105 minutes practice would be found to be very great.

The Relation of Improvement to Initial Ability

The effect of equal practice upon groups of different initial ability within the same grade is to increase rather than reduce the initial differences. The facts are shown in Table 7. Those who by original capacity or circumstances of training are ahead at the start maintain and increase their lead. Since this is the result of this partial equalization of training, it would seem that their initial superiority must have been largely due to original capacity. Nature, not nurture, seems to be the chief cause of the differences in ability to add found in children of the same school grade. Equalizing opportunity does not seem to equalize achievement.

In closing we venture to remind the reader that out-of-school practice may be a factor by means of, or in spite of, which the facts so far described were caused. It is however improbable that many children practiced on this addition out of school at all; and it is improbable that the few who did so, wrote out and added enough columns to make any very great difference in their improvement.

We may then, with some considerable probability, apply all of our results to the case of similar practice *without* out-of-school exercise of the function, if we (1) reduce slightly the amount and rate of improvement, (2) regard the changes in

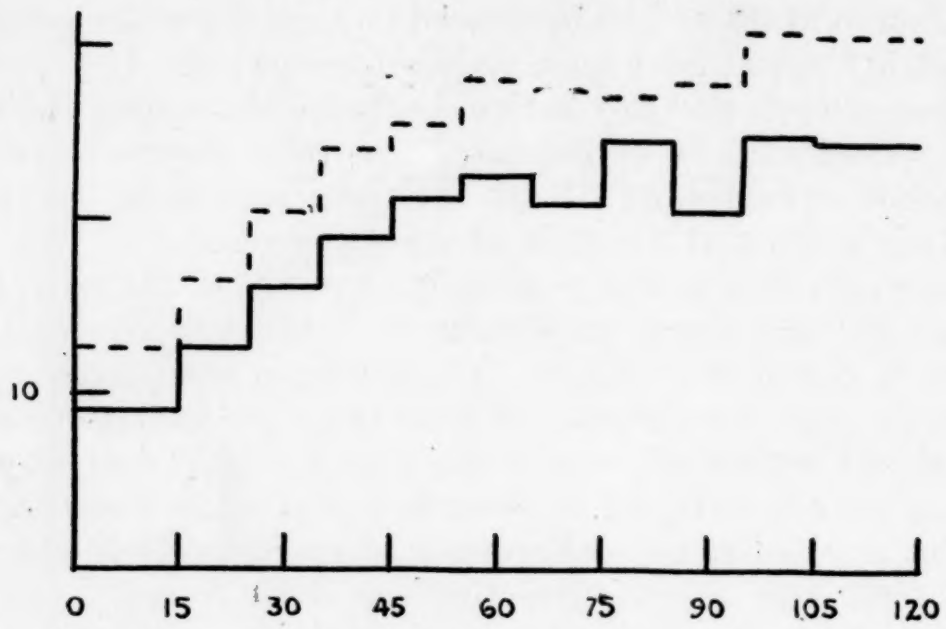

Fig. 7. Improvement in Adding: 4A. The horizontal scale is for minutes spent in practice; the vertical scale is for the score made. The continuous line gives the number of correct answers per 15 minutes; the dash line gives the number correct plus half the number wrong.

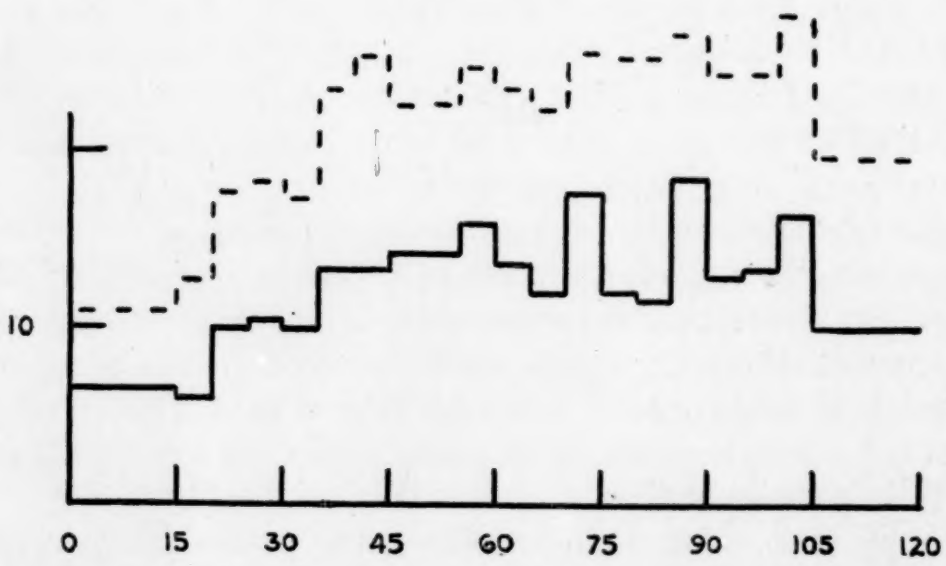

Fig. 8. Improvement in Adding: 4B. The horizontal scale is for minutes spent in practice; the vertical scale is for the score made. The continuous line gives the number of correct answers per 15 minutes; the dash line gives the number correct plus half the number wrong.

TABLE 5.

Number of 10-digit Examples Added Correctly in Initial 15-minute Test.

Quantity	Frequency Grade 4	Grade 5	Grade 6	Grade 7
0	2			
1			1	
2	2	1		
3	4	1	1	
4	4	2	1	
5		2	1	
6	2			
7	3		1	
8	2			1
9	3	7	2	1
10	1	3	1	
11		3	2	1
12	6	4	5	
13	2	1	2	1
14		1	1	1
15	3	4		
16	3	3	4	1
17		1	3	
18	1	1		
19		2	3	
20		1	2	3
21		2		3
22	1	1	3	3
23		1		3
24		3	3	1
25		1	1	3
26			3	1
27		2		2
28			1	3
29		1		
30				
31				2
32			1	2
33		1		1
34			1	
35				1
36				1
37				
38				1
39				

Also 1 at 52.
Also 1 at 54.

TABLE 6.

Gain in Number of Examples Added Correctly in 15 Minutes in the Groups with Full Practice.

Quantity	Frequency Grade 4	Grade 5	Grade 6	Grade 7
—11			1	
—10				
— 9				
— 8		1		
— 7		1		
— 6	1			
— 5				
— 4	1	2		
— 3				
— 2				
— 1	1			
0		2	1	
1		2	1	1
2			3	
3	2	2		
4		2		
5	1	1		
6		3	2	1
7			3	
8	2	2	2	2
9		3	1	1
10		1	2	
11		1		2
12	2			1
13	4	2		
14	2		1	
15	1			
16	1		2	
17		4	1	1
18	2	2	1	1
19	1	1		2
20		1		2
21				
22	1			1
23	1			1
24				3
25			1	1
26				1
27		1		
28		1		2
29			1	1
30				1
31	1	1	1	
32		1	1	

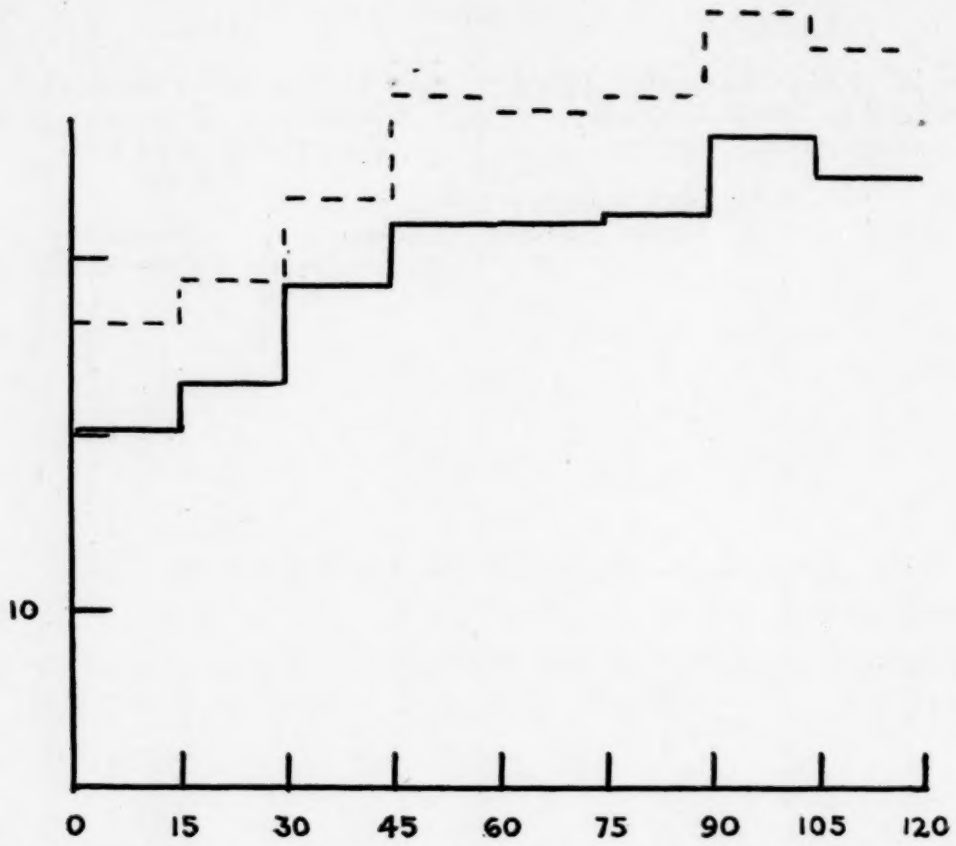

Fig. 9. Improvement in Adding: 6 and 7. The horizontal scale is for minutes spent in practice; the vertical scale is for the score made. The continuous line gives the number of correct answers per 15 minutes; the dash line gives the number correct plus half the number wrong.

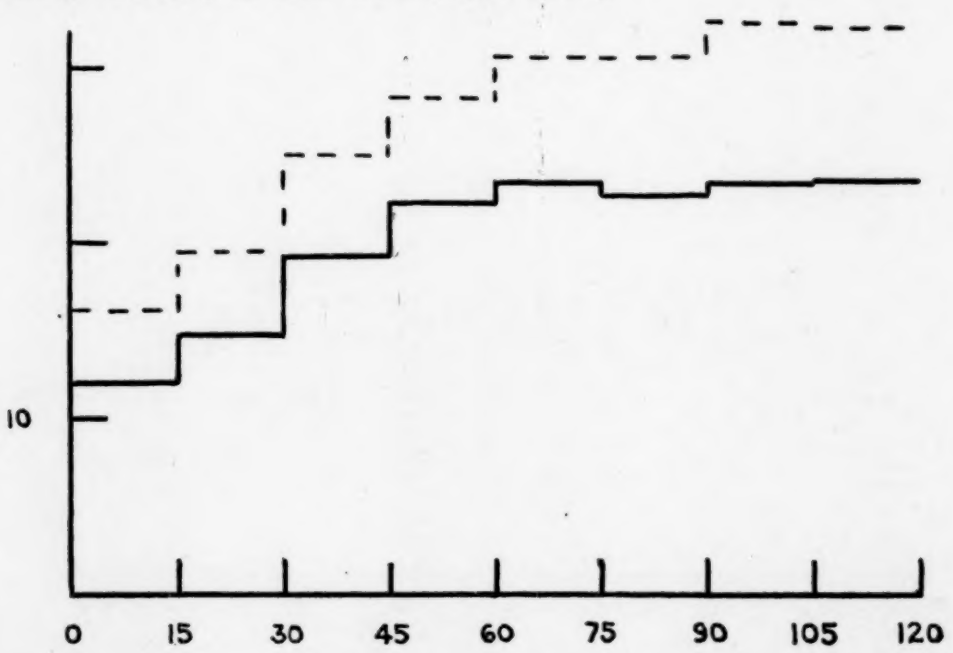

Fig. 10. Improvement in Adding: 4 and 5. The horizontal scale is for minutes spent in practice; the vertical scale is for the score made. The continuous line gives the number of correct answers per 15 minutes; the dash line gives the number correct plus half the number wrong.

TABLE 7.

The Amount of Improvement in Relation to Initial Ability.

Average Gross Gains of Groups of Defined Initial Ability. The score used is the number of correct answers. The figures in parentheses give the number of pupils in question.

	1 Grade 4		2 Grade 5		3 Grade 6		4 Grade 7		Average of 1, 2, 3 and 4
0 to 6	12.3	(10)	10.7	(7)	9.0	(21)			10.7
7 to 12	7.6	(9)	9.7	(12)	10.1	(9)	15.0	(2)	10.6
13 to 18	13.4	(5)	7.6	(8)	12.3	(6)	17.5	(2)	12.7
19 to 24	6.7	(3)	19.5	(4)	11.0	(6)	20.4	(9)	12.3
25 to 30	...		12.3	(4)	1.5	(2)	23.4	(6)	12.4
31 to 36	...		54.0	(1)	8.5	(2)	16.4	(5)	?
37 to 42							9	(1)	?

rate as possibly due to or cut down by the changes in the amount of home work, (3) admit that the comparison of A groups with B groups is complicated by the greater likelihood of home work in the A groups and (4) admit that the individual differences in gains may be in some measure due to individual differences in the amount of home work done.

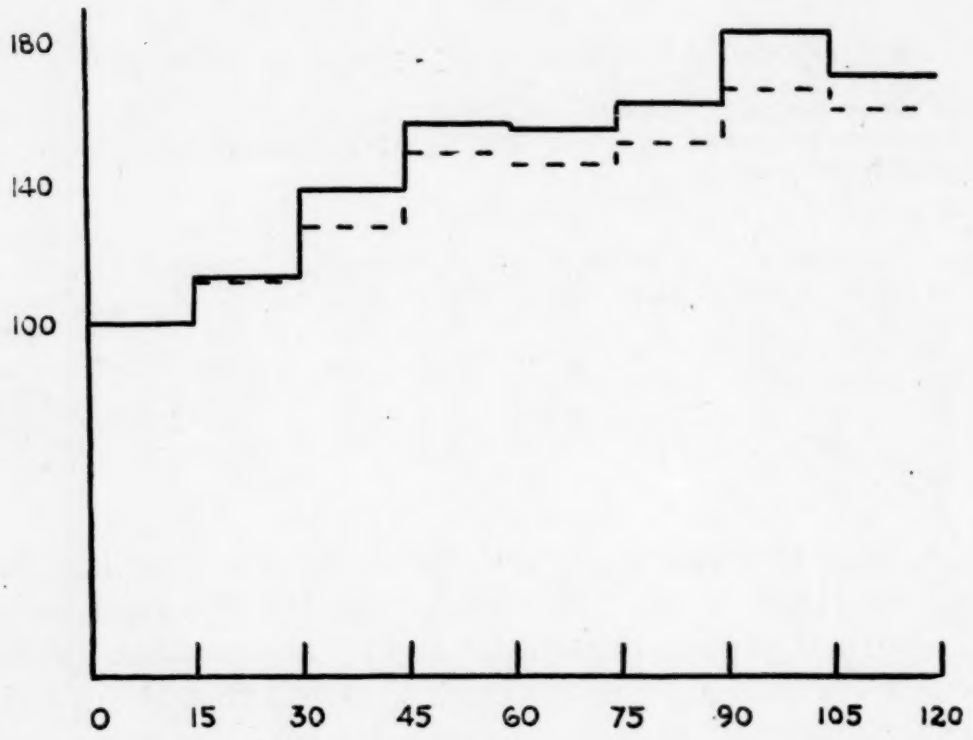

Fig. 11. Improvement in Adding: 6 and 7. The horizontal scale is for minutes spent in practice; the vertical scale is for the score made, expressed as a percentage of the score in the first test. The continuous and dash lines mean as in Figs. 1-10.

Fig. 12. Improvement in Adding: 4 and 5. The horizontal scale is for minutes spent in practice; the vertical scale is for the score made, expressed as a percentage of the score in the first test. The continuous and dash lines mean as in Figs. 1-10.

THE RELATION OF LENGTH OF MATERIAL TO TIME TAKEN FOR LEARNING

and

THE OPTIMUM DISTRIBUTION OF TIME.

DARWIN OLIVER LYON,
Columbia University.

Part II.

I have given the preceding brief summary of the results of the various investigations on The Relation of Length of Material to Number of Repetitions, not only as an historical review of those who have worked along these lines, but also because it allowed me to bring in at the same time for purposes of comparison, results obtained from certain experiments of my own. These experiments will now be considered in detail.

It was stated in Part I that in investigating the relation of length of material to time taken for learning we may, in the learning, use various *methods*. In the following experiments only two were used. I have designated them as (1) the "continuous" method, and (2) the "once-per-day" method. In the former, the subject is allowed to memorize the material *en-masse*,—i. e., in one sitting;—in the latter, the subject memorizes the material by reading it once a day—and once only, until memorized. The curves shown in the following plates, therefore, show not only the relation of length of material to time taken for learning, but they give a comparison of the total time taken to learn any passage by the one method as compared with the total time taken to learn a passage of the same length by the other method.

As will be seen from the plates, with their accompanying tables, the length of time taken to learn a passage of prose or a set of nonsense syllables, depends in large measure on the *method used* in performing the learning. In one sense of the word, therefore, it would be more fitting to call this experi-

ment *The Relation of Length of Material to Time Taken for Learning when said Learning is Performed in one Sitting;* and, *The Relation of Length of Material to Time Taken for Learning when said Learning is Performed by the "Once-per-day" Method.*

The materials first used were nonsense syllables and poetry. With these the experiment was continued for 14½ months. Digits and prose were then substituted and the entire performance repeated. The manner of conducting the experiment was as follows:— On May 1, 1908, I memorized 8 nonsense syllables taking my time by the watch. In the evening of the same day I memorized a four-line stanza of poetry of twenty-four words. An interval of two days was then allowed to elapse. On the following day (May 4th) a similar set of eight nonsense syllables was read once. Realizing that this reading was not sufficient for a perfect reproduction, the syllables were laid aside to be read the following morning. On the evening of May 4th, a stanza of poetry similar to the one previously memorized was read thru once. A perfect reproduction of the stanza was possible after this one reading, so this finished the two sets of eight nonsense syllables and the two sets of one-stanza poetry passages, both for the "continuous" method and the "once-per-day" method. From previous work with nonsense syllables it had been found that, when memorized by the "once-per-day" method they "clung" with great tenacity, and it was deemed advisable, therefore, to allow an interval of one week to elapse before starting on the next set. Therefore, it was not until the morning of May 15th that the twelve-syllable set was started. In the meantime, however, i. e., on May 5th, a passage of poetry consisting of *two* stanzas was memorized by the "continuous" method. An interval of one day (May 6th) was then allowed to elapse and on May 7th a similar passage of two stanzas was read once and once only. Three readings were necessary to get this two-stanza passage, i. e., it was read on the 7th, 8th and 9th. An interval of one day was then allowed to elapse, after which a *three-stanza* passage was started.[1]

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[1]This is all shown on plates I, II, III and IV; plates I and II being for nonsense syllables and plates III and IV for poetry.

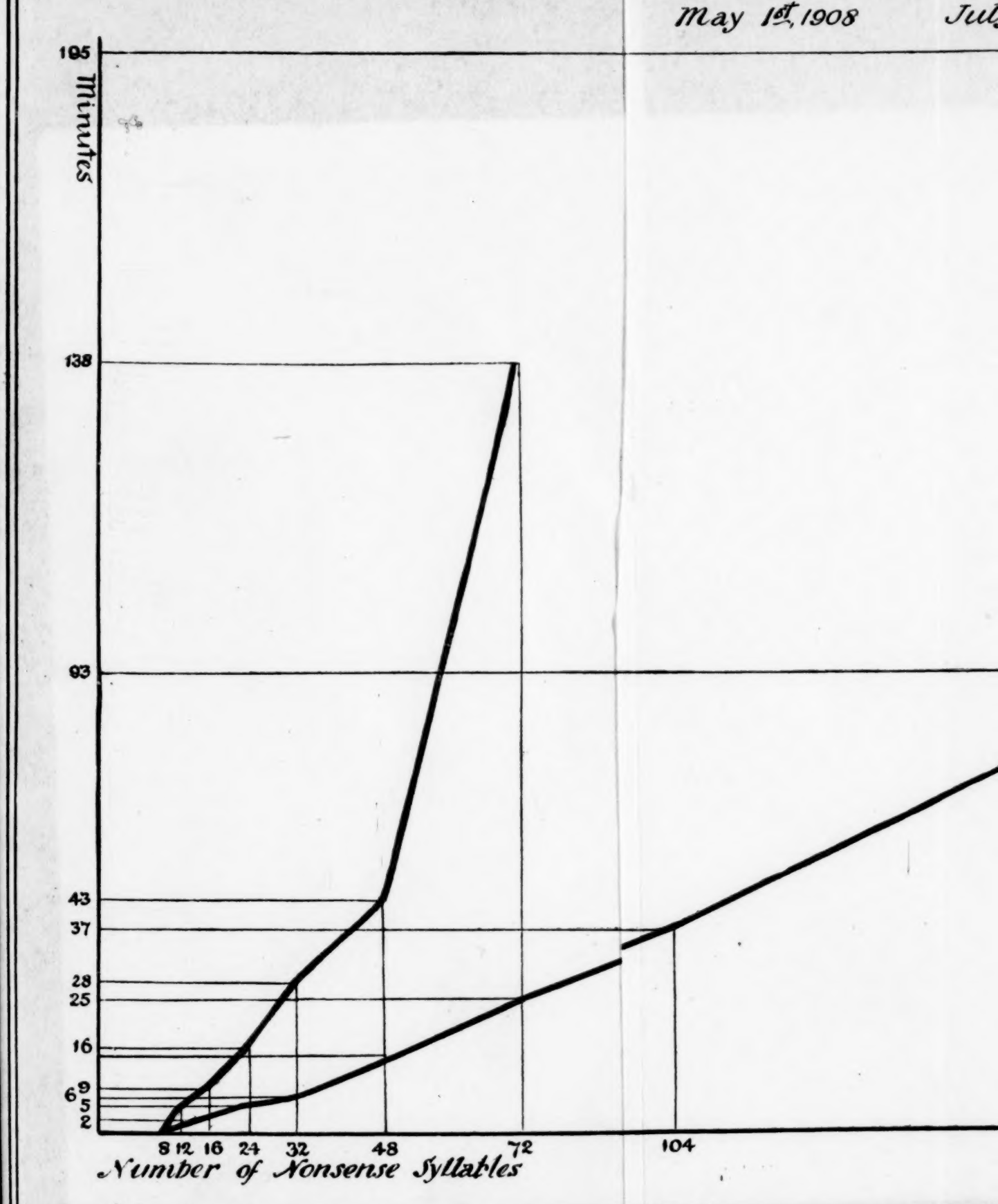
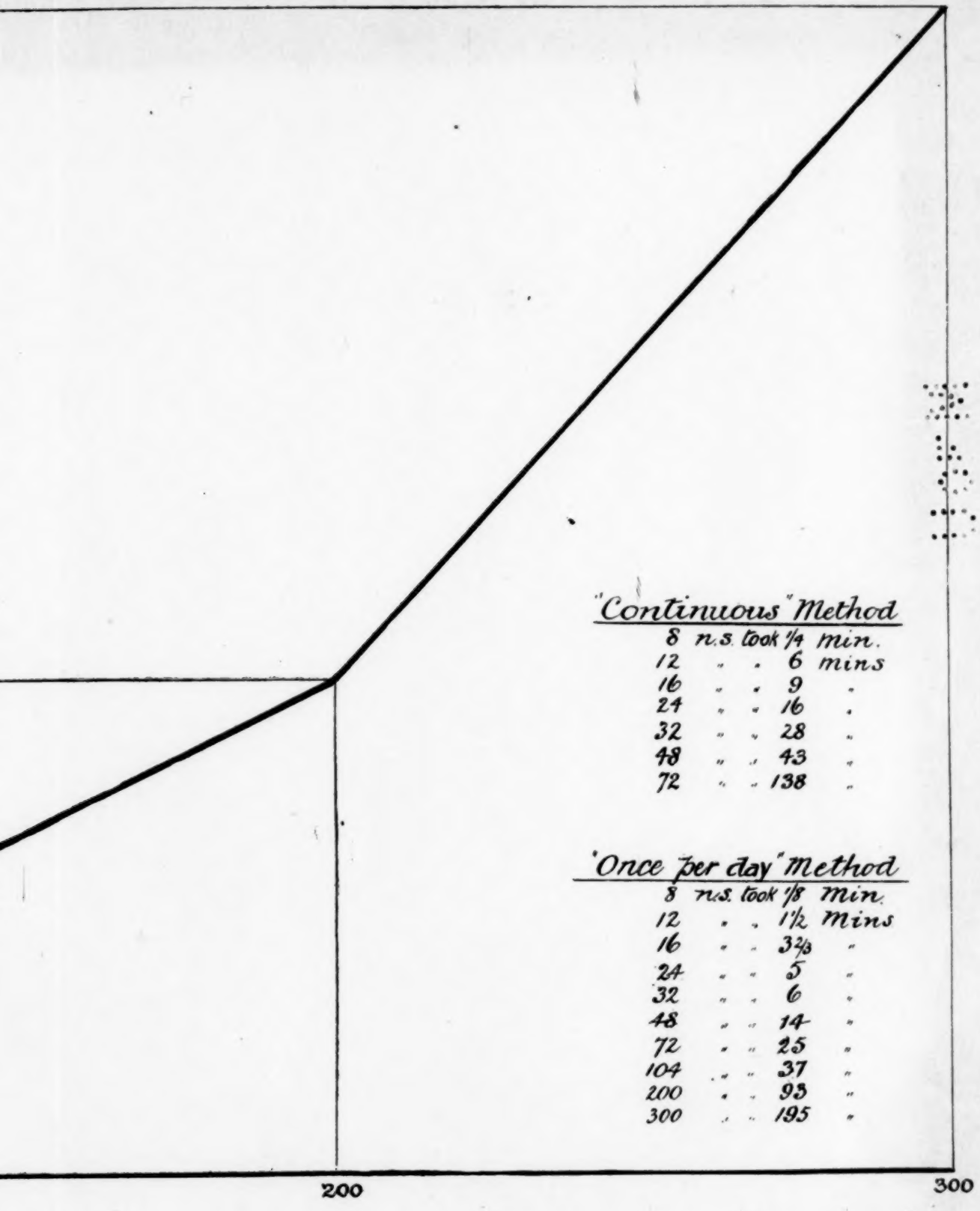


PLATE I. **NONSENSE SYLLABLES.** The black "curvshows the total time spent by the "
syllables ranging from 8 to 300. The "continuous" mod is shown in red.

July 10th, 1909.



nt by the "once-per-day" method, at the rate of two syllables per second, for sets of nonsense

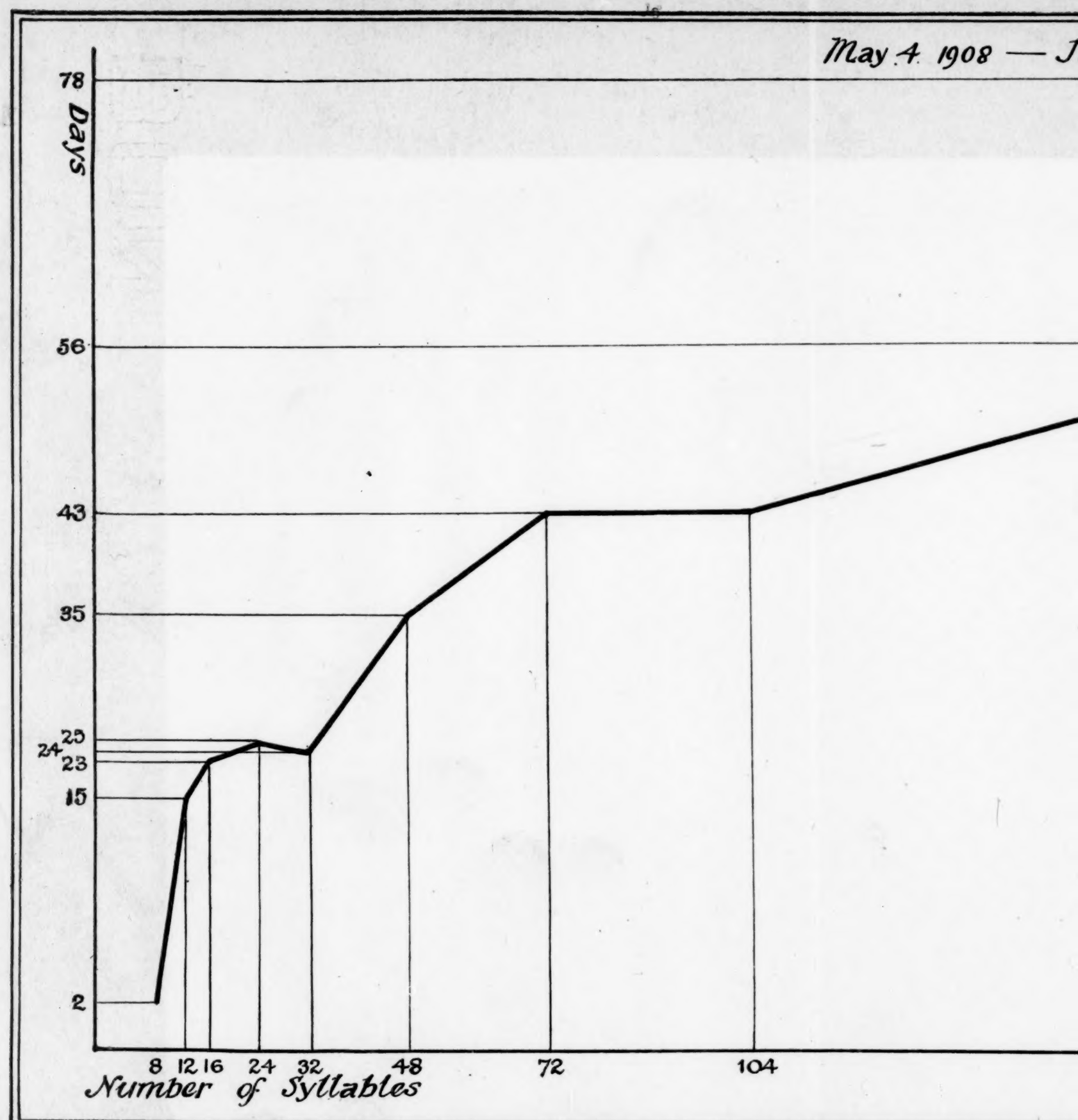
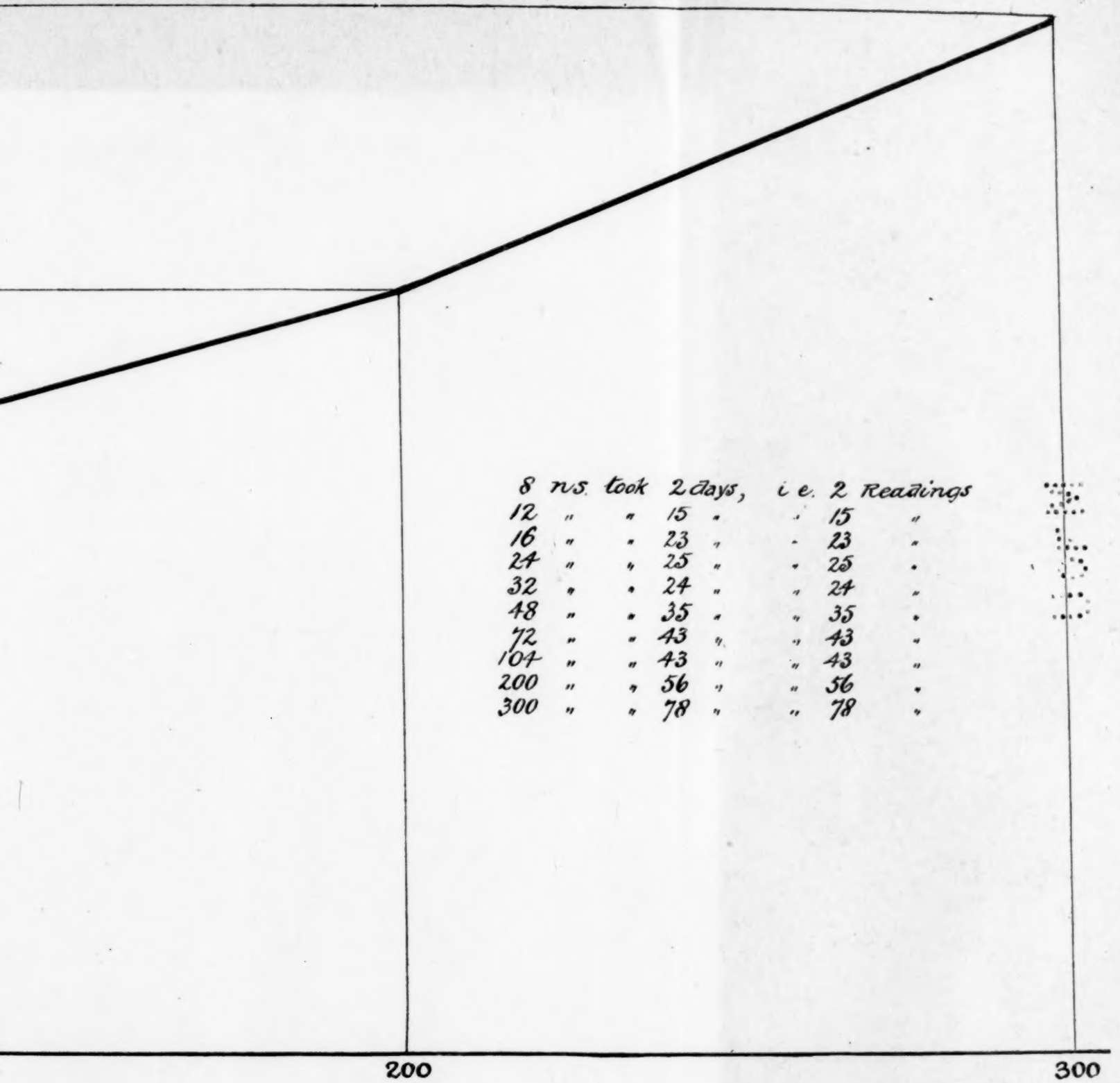


PLATE II. **NONSENSE SYLLABLES.** "Once-per-day" method. The curve shows the number

8 — July 10. 1909.



the number of readings necessary to memorize sets of nonsense syllables ranging from 8 to 300.

Continuous Method

1 Stanza (25 Words) took 1/8 Min
2 " (50 ") " 1½ "
3 " (105 ") " 4 "
4 " (100 ") " 5 "
5 " (125 ") " 10 "
6 " (150 ") " 9 "
7 " (245 ") " 16 "
8 " (200 ") " 19 "
10 " (250 ") " 26 "
12 " (300 ") " 28 "
15 " (525 ") " 34
18 " (450 ") " 30 "
21 " (525 ") " 44 "
25 " (625 ") " 56 "
30 " (1050 ") " 122 "
35 " (875 ") " 114 "
40 " (1000 ") " 124 "
50 " (1250 ") " 147 "
60 " (2100 ") " 185 "
75 " (1875 ") " 190 "
100 " (2500 ") " 312 "

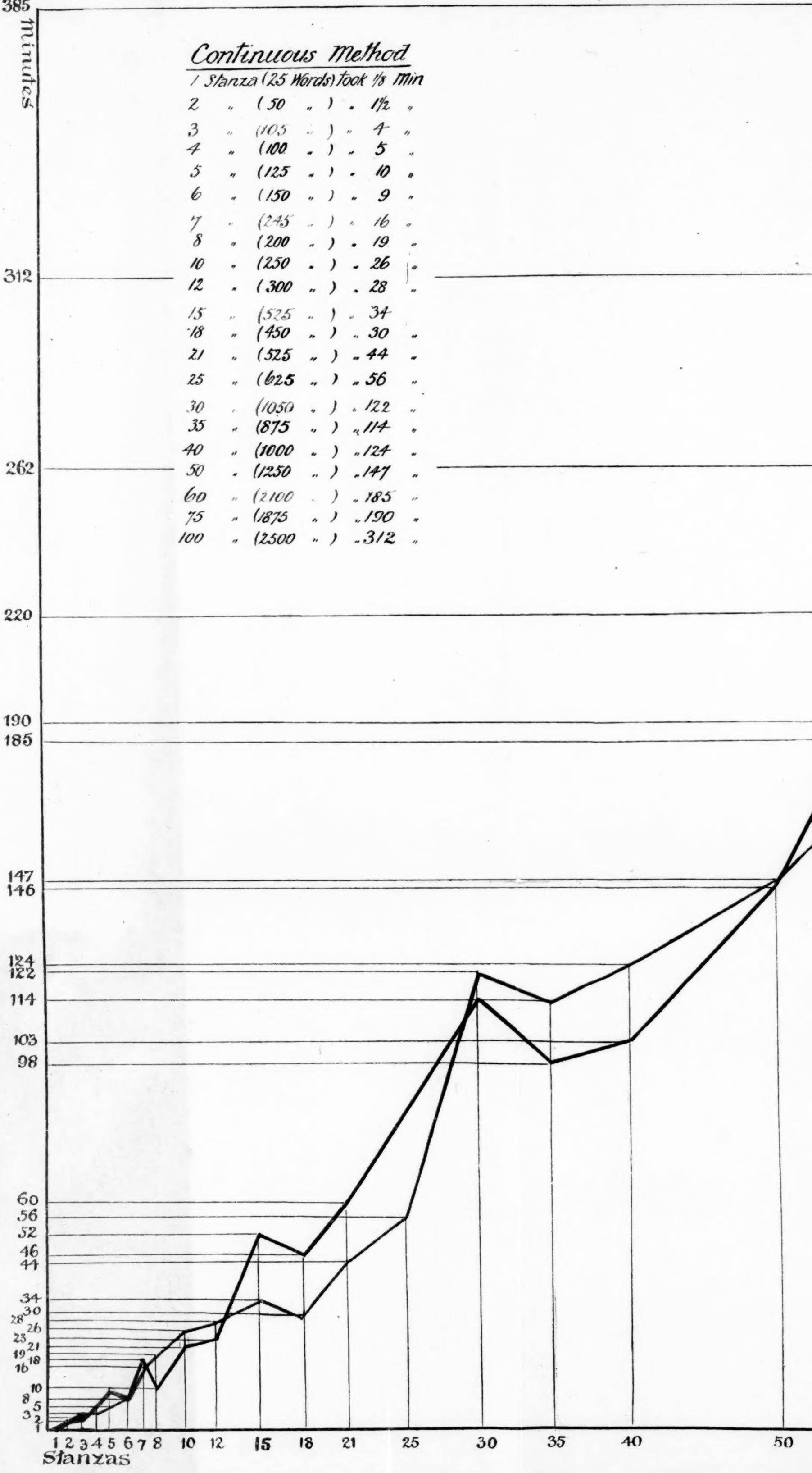
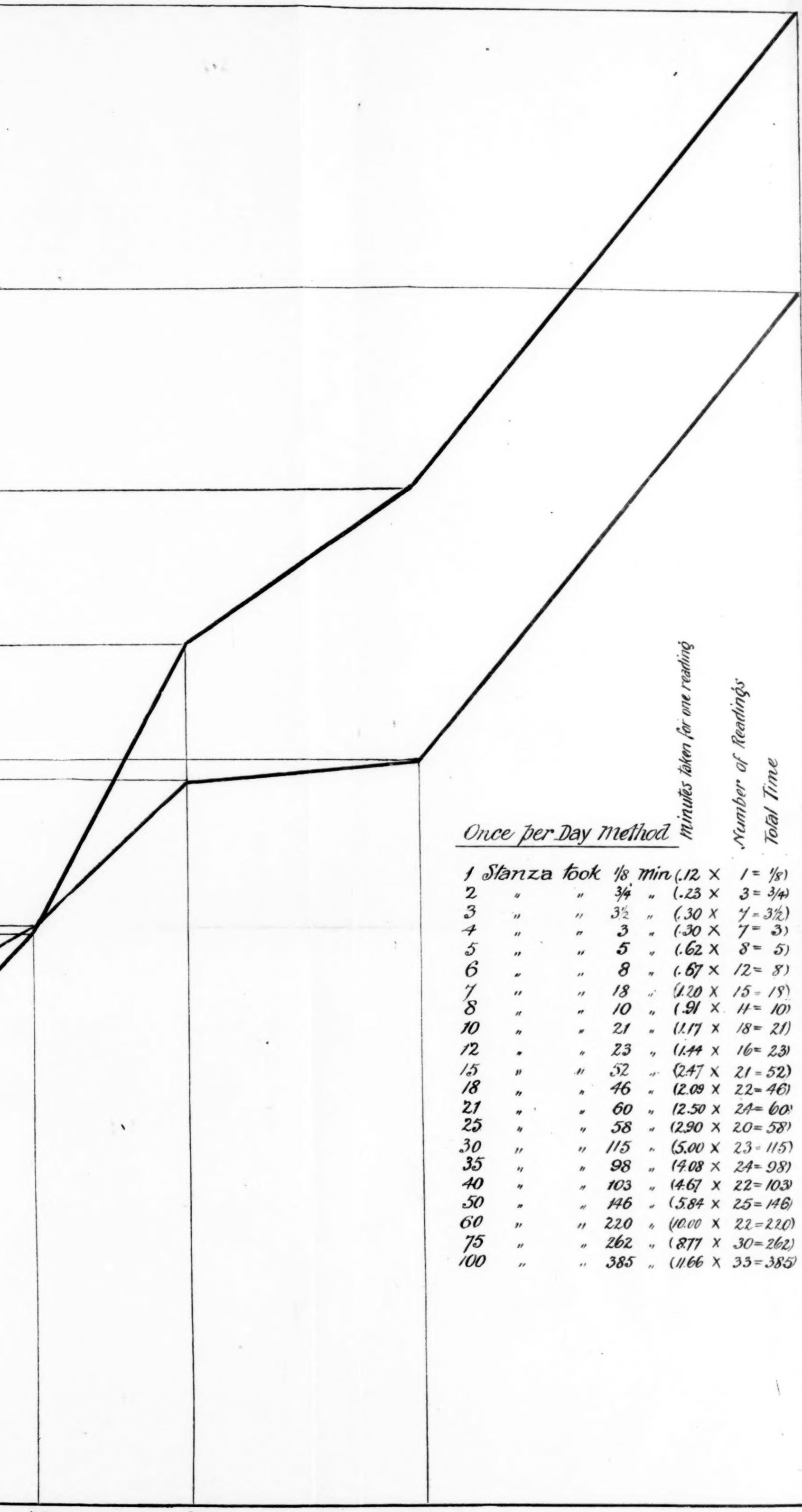


PLATE III. **POETRY.** The blac
day" method at the rate of 7
passages of poetry range fro
tinuous" method is shown in
lower margin—denote those
all other stanzas being 4-line

*Excepting the 6-line



Once per Day method			minutes taken for one reading		Number of Readings	Total Time
1	Stanza	took	1/8	min	(.12 ×	1 = 1/8)
2	"	"	3/4	"	(.23 ×	3 = 3/4)
3	"	"	3½	"	(.30 ×	7 = 3½)
4	"	"	3	"	(.30 ×	7 = 3)
5	"	"	5	"	(.62 ×	8 = 5)
6	"	"	8	"	(.67 ×	12 = 8)
7	"	"	18	"	(1.20 ×	15 = 18)
8	"	"	10	"	(.91 ×	11 = 10)
10	"	"	21	"	(1.17 ×	18 = 21)
12	"	"	23	"	(1.44 ×	16 = 23)
15	"	"	52	"	(2.47 ×	21 = 52)
18	"	"	46	"	(2.09 ×	22 = 46)
21	"	"	60	"	12.50 ×	24 = 60)
25	"	"	58	"	(2.90 ×	20 = 58)
30	"	"	115	"	(5.00 ×	23 = 115)
35	"	"	98	"	(4.08 ×	24 = 98)
40	"	"	103	"	(4.67 ×	22 = 103)
50	"	"	146	"	(5.84 ×	25 = 146)
60	"	"	220	"	(10.00 ×	22 = 220)
75	"	"	262	"	(8.77 ×	30 = 262)
100	"	"	385	"	(11.66 ×	33 = 385)

50 60 75 100

. The black "curve" shows the total time spent by the "once-per-
e rate of 7 seconds per stanza,* or 5 minutes per 1000 words. The
y range from 1 to 100 stanzas in length. The "curve" for the "*con-*
s shown in red. The red figures—both in the tables and on the
note those passages composed of 6-line stanzas of 35 words each,
being 4-line and averaging 25 words each.

ng the 6-line stanzas, which require 10 seconds per stanza.

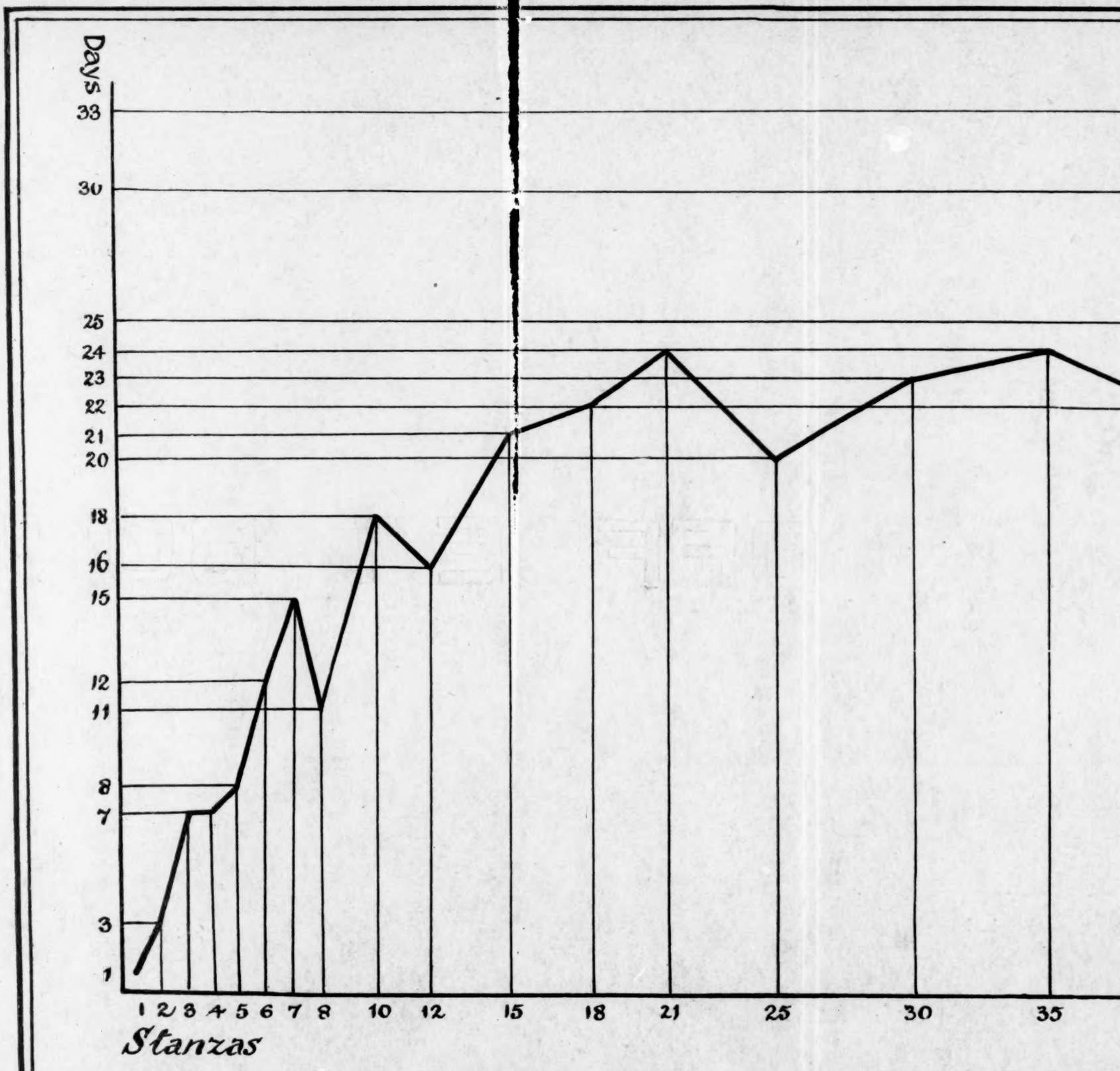
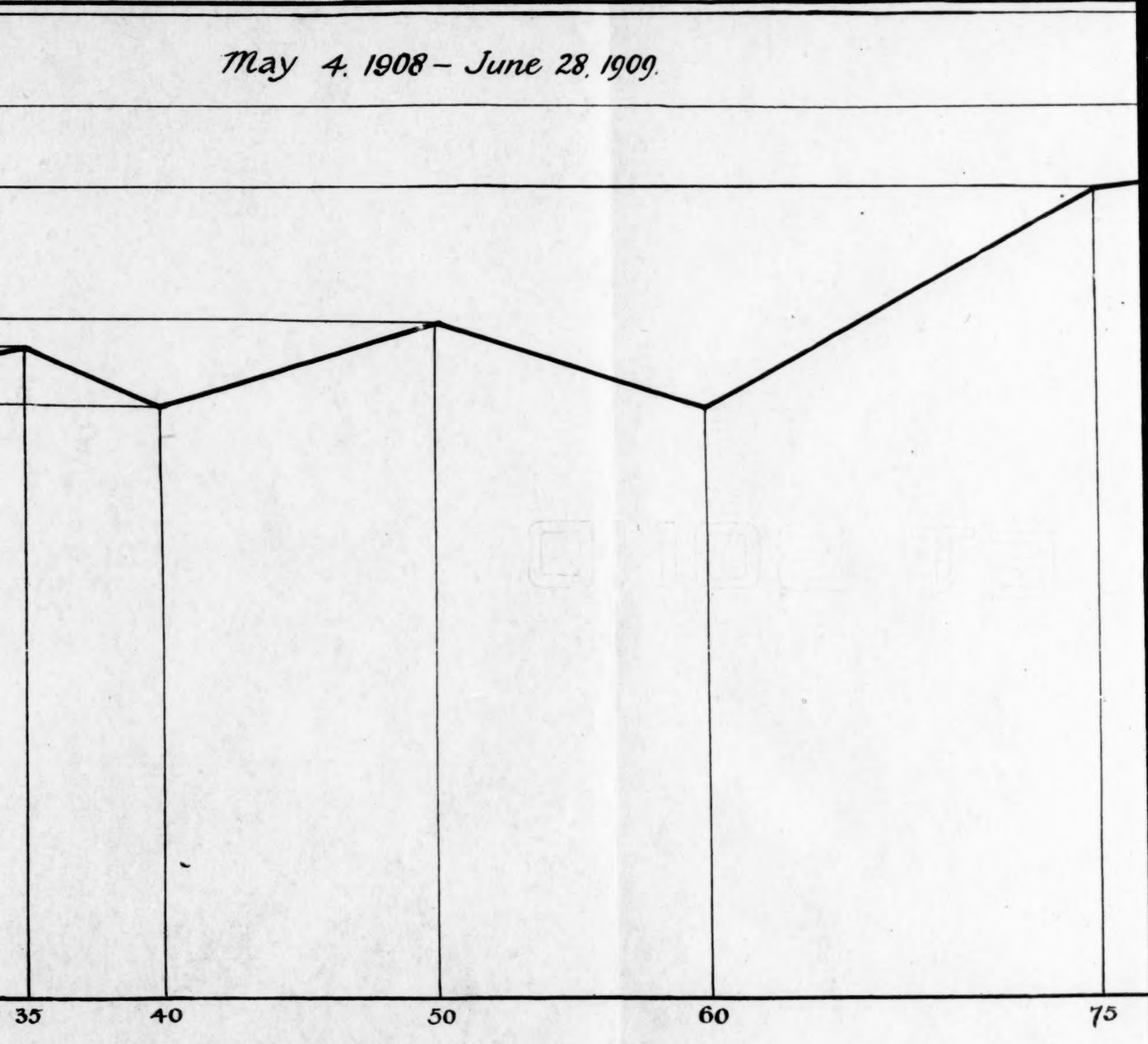


PLATE IV. F
ings neces
length. T
average 35



ATE IV. **POETRY.** "Once-per-day" method. The curve shows the number of readings necessary to memorize passages of poetry ranging from 1 to 100 stanzas in length. The stanzas average 25 words each, excepting those shown in red, which average 35 words each.

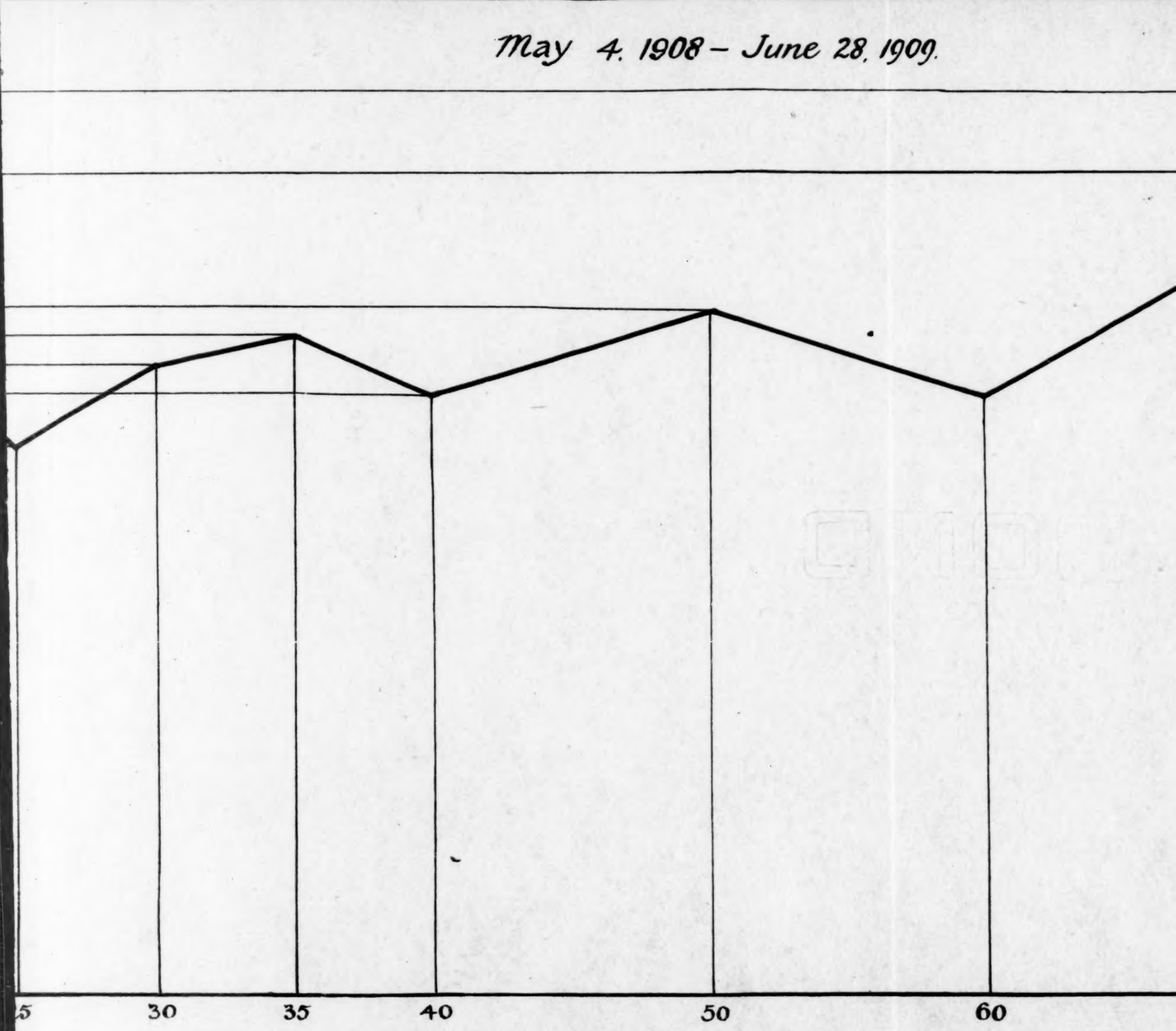
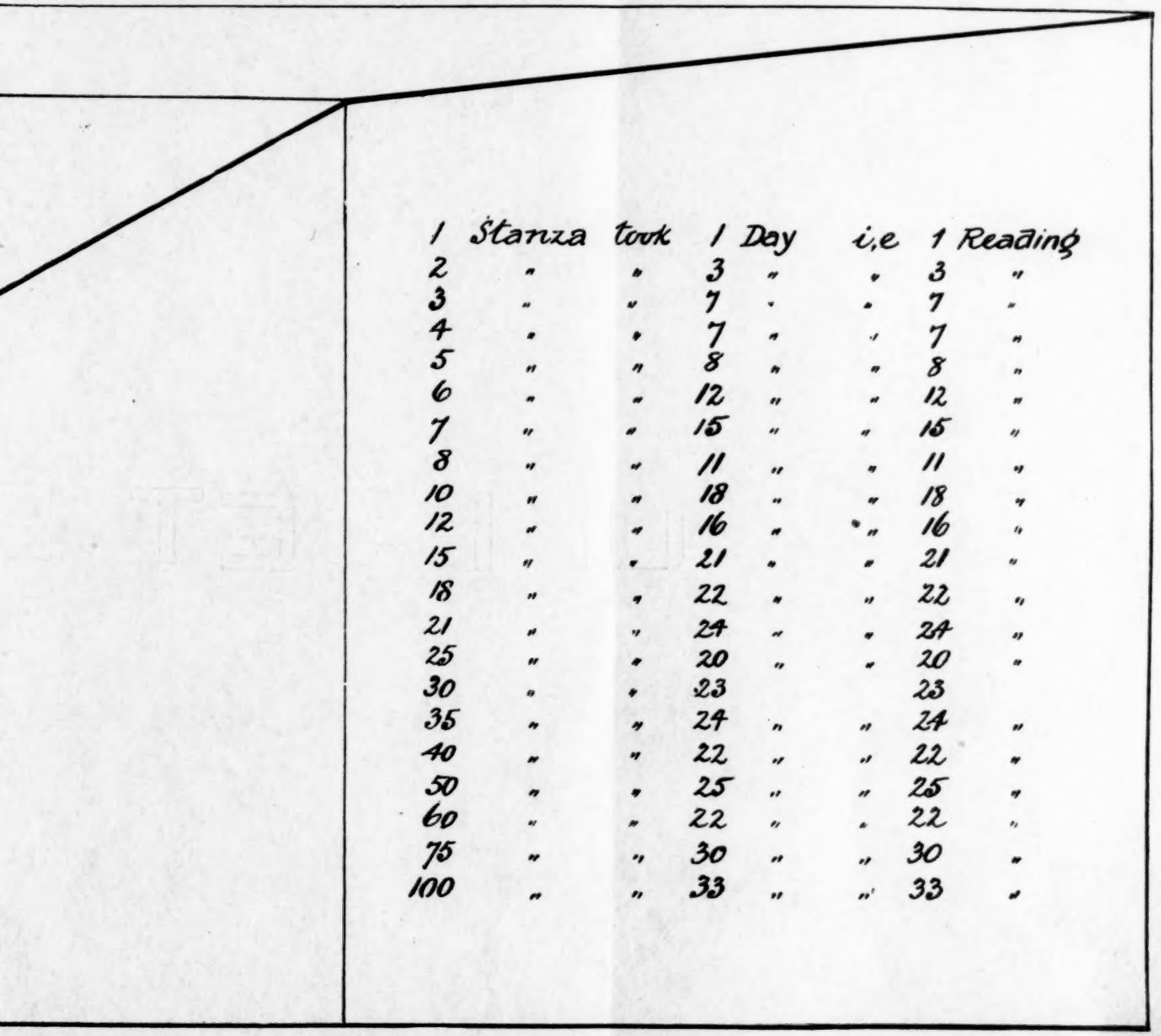


PLATE IV. **POETRY.** "Once-per-day" method. The curve shows the number of readings necessary to memorize passages of poetry ranging from 1 to 100 stanzas in length. The stanzas average 25 words each, excepting those shown in red, which average 35 words each.



1	Stanza	took	1	Day	i,e	1	Reading
2	"	"	3	"	"	3	"
3	"	"	7	"	"	7	"
4	"	"	7	"	"	7	"
5	"	"	8	"	"	8	"
6	"	"	12	"	"	12	"
7	"	"	15	"	"	15	"
8	"	"	11	"	"	11	"
10	"	"	18	"	"	18	"
12	"	"	16	"	"	16	"
15	"	"	21	"	"	21	"
18	"	"	22	"	"	22	"
21	"	"	24	"	"	24	"
25	"	"	20	"	"	20	"
30	"	"	23			23	
35	"	"	24	"	"	24	"
40	"	"	22	"	"	22	"
50	"	"	25	"	"	25	"
60	"	"	22	"	"	22	"
75	"	"	30	"	"	30	"
100	"	"	33	"	"	33	"

75

100

In this manner the experiment was continued for over fourteen months. Nonsense syllables were always read in the morning,—poetry, in the evening. After finishing each passage of poetry, whether by the "continuous" method or the "once-per-day" method, an interval of one day was allowed to elapse. With the nonsense syllables, however, a longer interval was deemed necessary—two days being allowed to elapse after each finishing with the "continuous" method and seven days after the "once-per-day" method. The reasons for making the intervals longer for the nonsense syllables are, of course, obvious. It should be said here that no other experiments on memory were conducted while this experiment was in progress, and neither nonsense syllables nor poetry of any nature was read during the entire period. To make the conditions of the experiment as scientifically accurate as possible, the nonsense syllables and poetry were taken at as widely different times of the day as possible,—the nonsense syllables being read in the morning before breakfast, and the poetry in the evening after supper. It was also deemed best to abstain from all reading for a period of at least one half hour both before and after the reading of each passage.

On June 28th, 1909, I finished with the passage of poetry consisting of 100 stanzas. On July 10th I finished with the set of 300 nonsense syllables. Feeling that the experiment had continued long enough with these materials as subject matter, I decided to repeat the experiment using this time, however, digits and prose. This new series of experiments was started on August 1st, 1909, and continued for three years, i. e., up to May 2nd, 1912.[2]

The nonsense syllables were selected and made into sets after a certain definite manner.[3] A typical set is given in Part III. As may be seen from Plate 3, the poetry ranged in length from one to one hundred stanzas both for the "continuous" method and the "once-per-day" method. The poetry selected was what is known as common meter, i. e., iambic verses in which the first line contains four feet and the second line three feet. As shown on Plate 3, however, (where the

[2]This was so only for the prose. The digits were discontinued on August 10, 1910.

[3]Described in foot-note No. 15, Part III, of this article.

"exceptional" type is printed in red) every fourth set of poetry used had six instead of four lines in each stanza. A typical example of the first type of poetry is given below. It is a stanza from Thomas Moore's *The Ring.*[4]

"The female fiend no sooner heard
Than, with reluctant look,
The very ring that Rupert lost,
She from her finger took."

As a typical example of the second type of poetry, I give Thomas Hood's *The Dream Of Eugene Aram,*

"He told how murderers walked the earth,
Beneath the curse of Cain,—
With crimson clouds before their eyes,
And flames about their brain;
For blood has left upon their souls
Its everlasting stain!"

It will be seen that this poem is of the same type as that of *The Ballad of Reading Gaol.* My reason for using these two types of poetry was that I wanted to see if the addition of two extra lines made any material difference with either the "once-per-day" method or the "continuous" method and if so, if the difference was greater with one than with the other.[5] It will be seen from a glance at Plate 3 that by neither method does the addition of the two extra lines make any perceptible difference in the time taken for learning,—outside of the fact, of course, that the stanza takes longer to read.

For prose I decided to use selections from four different authors, alternating one with the other as shown on Plate 7. The authors chosen were Spencer, Hugo, Schopenhauer and Ingersoll. Due to the fact that I alternated one author with the other, I at first made four separate curves, one for each author. It was seen, however, that there was so little difference with the different authors that one curve was thought sufficient. The selections from Schopenhauer took a somewhat longer time, due undoubtedly to the fact that the

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[4]This poem consists of sixty-two stanzas. The first 50 stanzas were used as the "50-stanza" set. As may be noted, the poem is of the same type as "*The Ancient Mariner.*"

[5]Stanzas of the shorter type averaged 24 to 25 words; stanzas of the longer type averaged 35 to 40. In Plate 3 in computing the total number of words I used the figures 25 and 35 respectively.

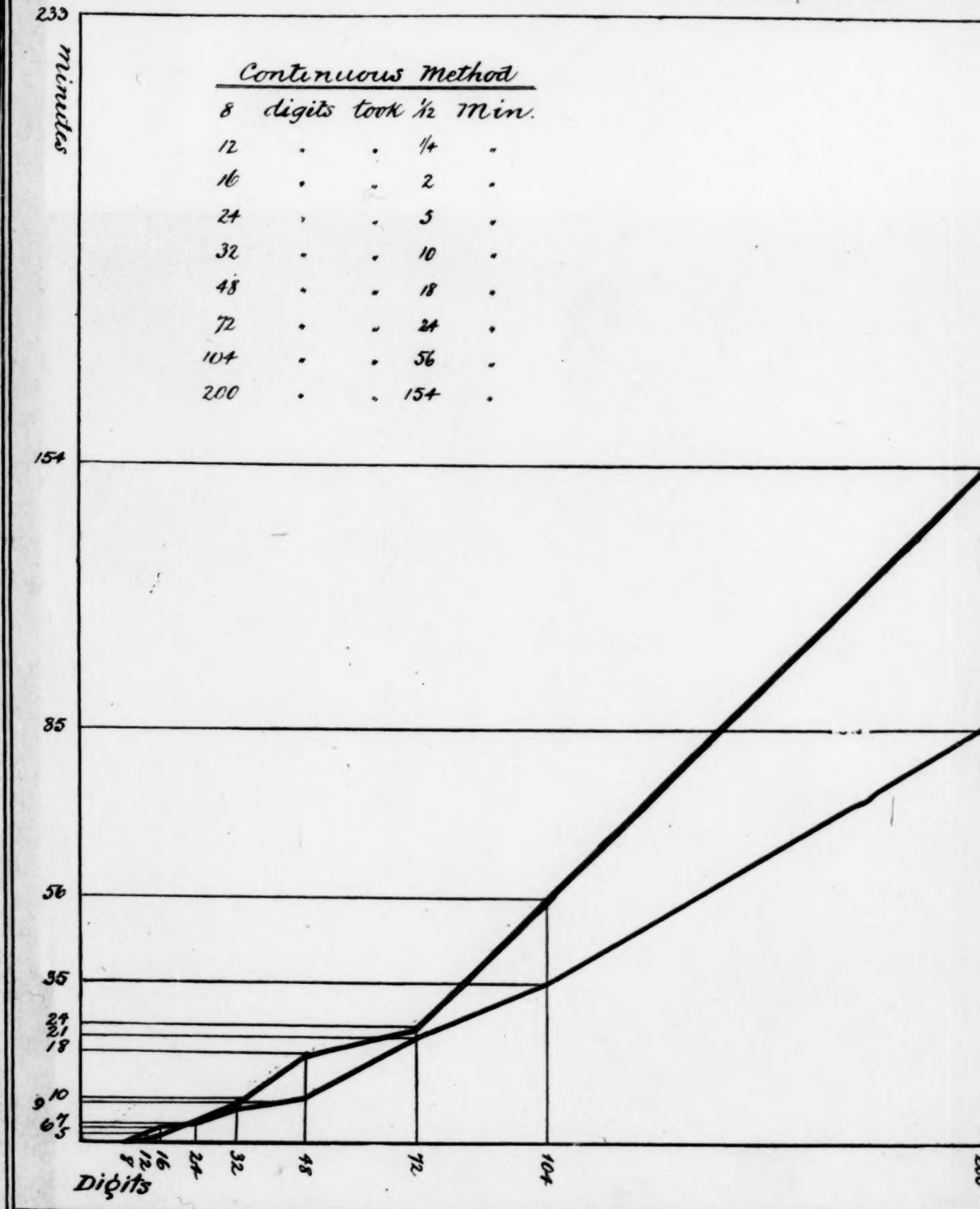
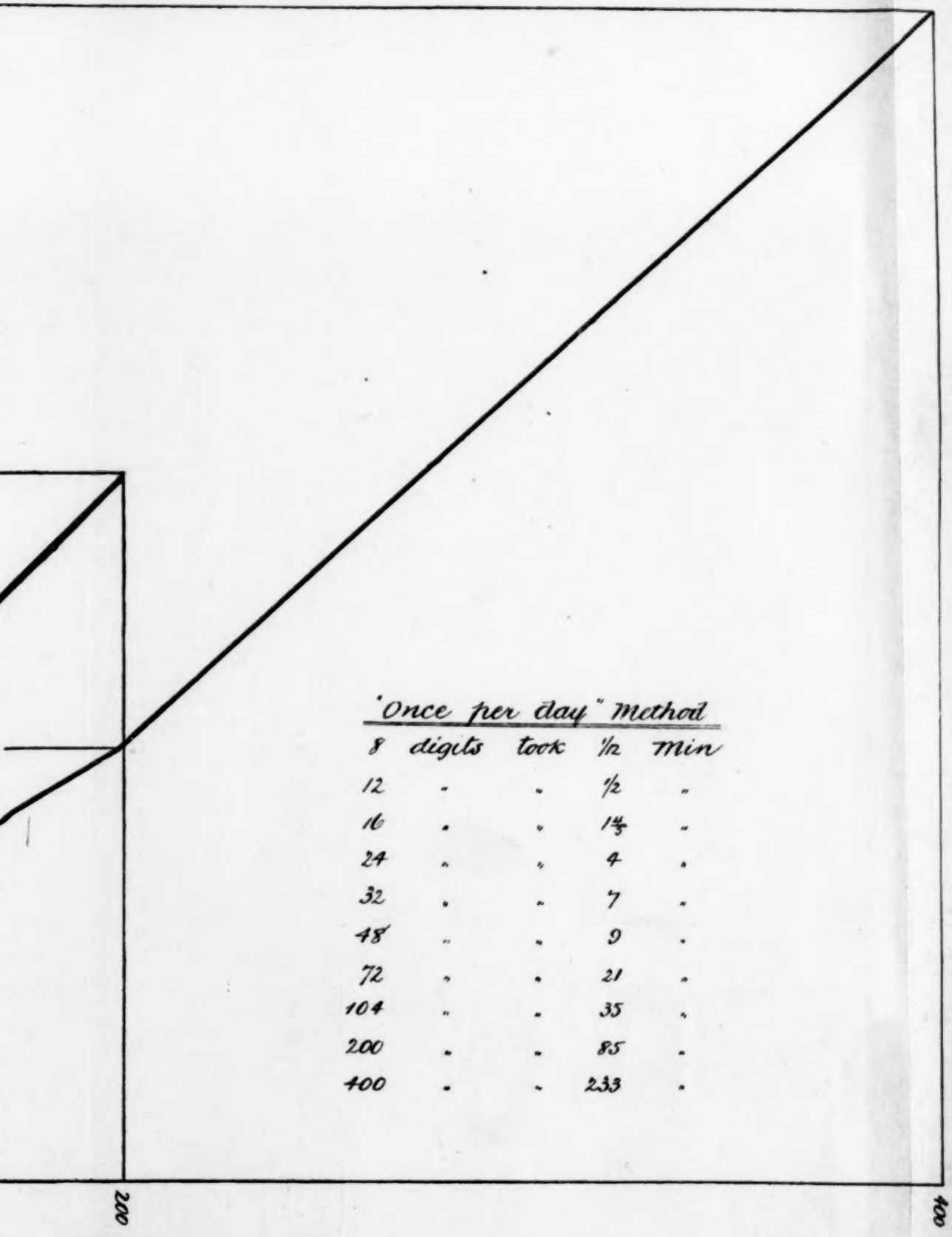


PLATE V. **DIGITS.** The black curve shows the total time spent by the "once-per-day" 400. The "continuous" method is shown in red.

09 — Aug 10 1910



"Once per day" Method

8	digits	took	½	Min
12	"	"	½	"
16	"	"	1⅓	"
24	"	"	4	"
32	"	"	7	"
48	"	"	9	"
72	"	"	21	"
104	"	"	35	"
200	"	"	85	"
400	"	"	233	"

ce-per-day" method, at the rate of two digits per second, for sets of digits ranging from 8 to

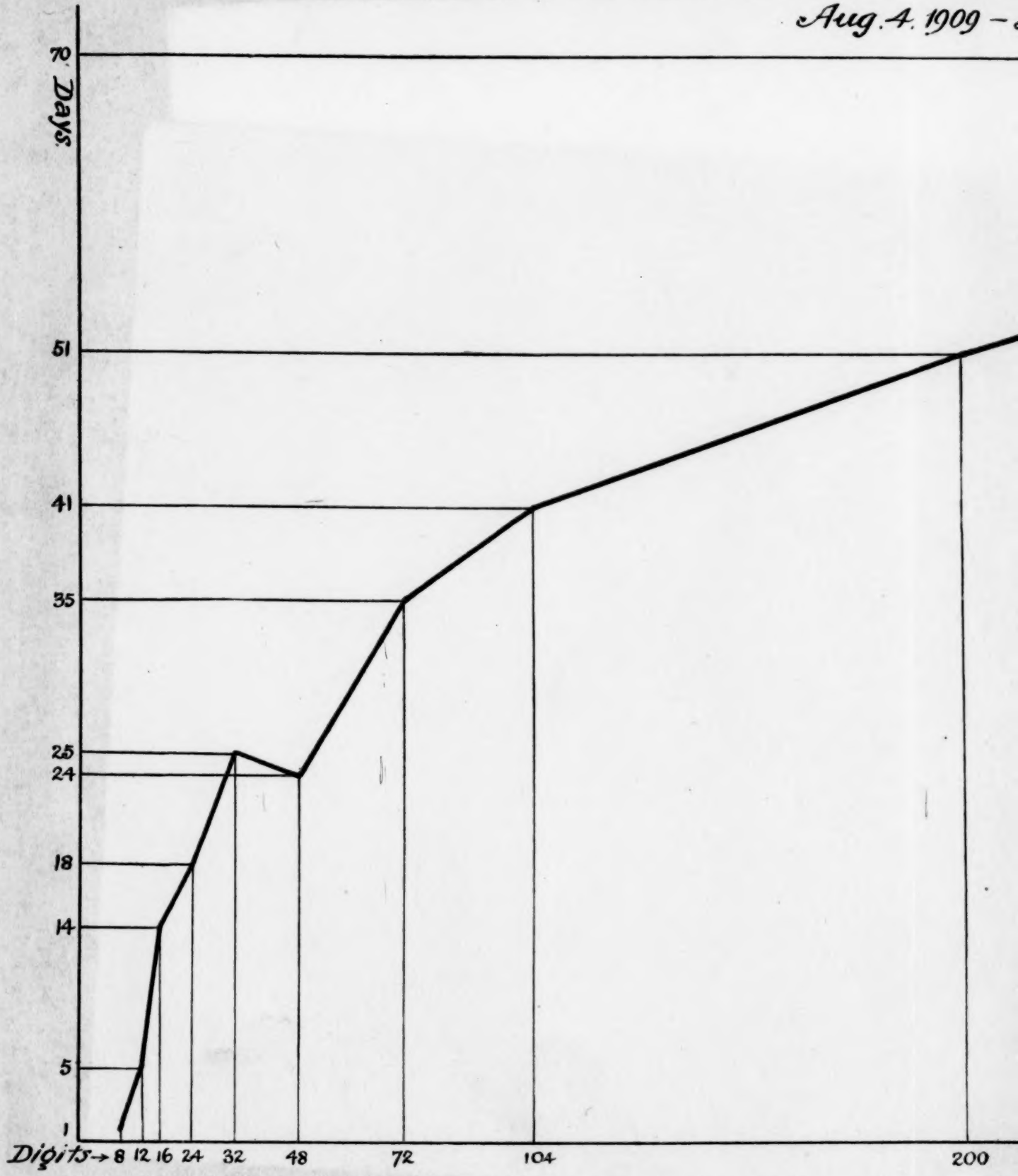
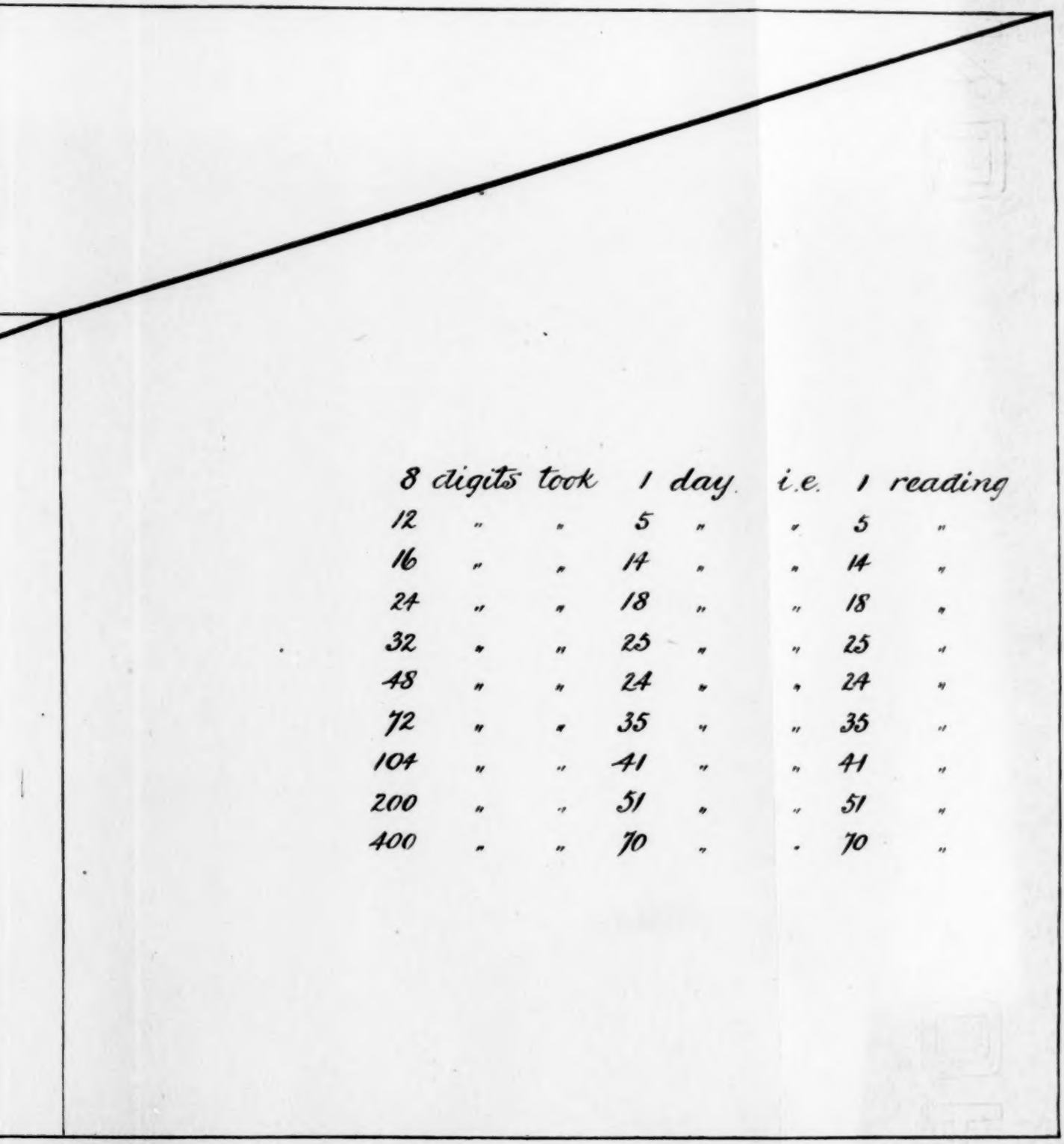


PLATE VI. DIGITS. "Once-per-day" method. The curve shows the numbe

4. 1909 – Aug. 10. 1910.



8	digits	took	1	day	i.e.	1	reading	
12	"	"	5	"	"	5	"	
16	"	"	14	"	"	14	"	
24	"	"	18	"	"	18	"	
32	"	"	25	"	"	25	"	
48	"	"	24	"	"	24	"	
72	"	"	35	"	"	35	"	
104	"	"	41	"	"	41	"	
200	"	"	51	"	"	51	"	
400	"	"	70	"	"	70	"	

200

400

the number of readings necessary to memorize sets of digits ranging from 8 to 400.

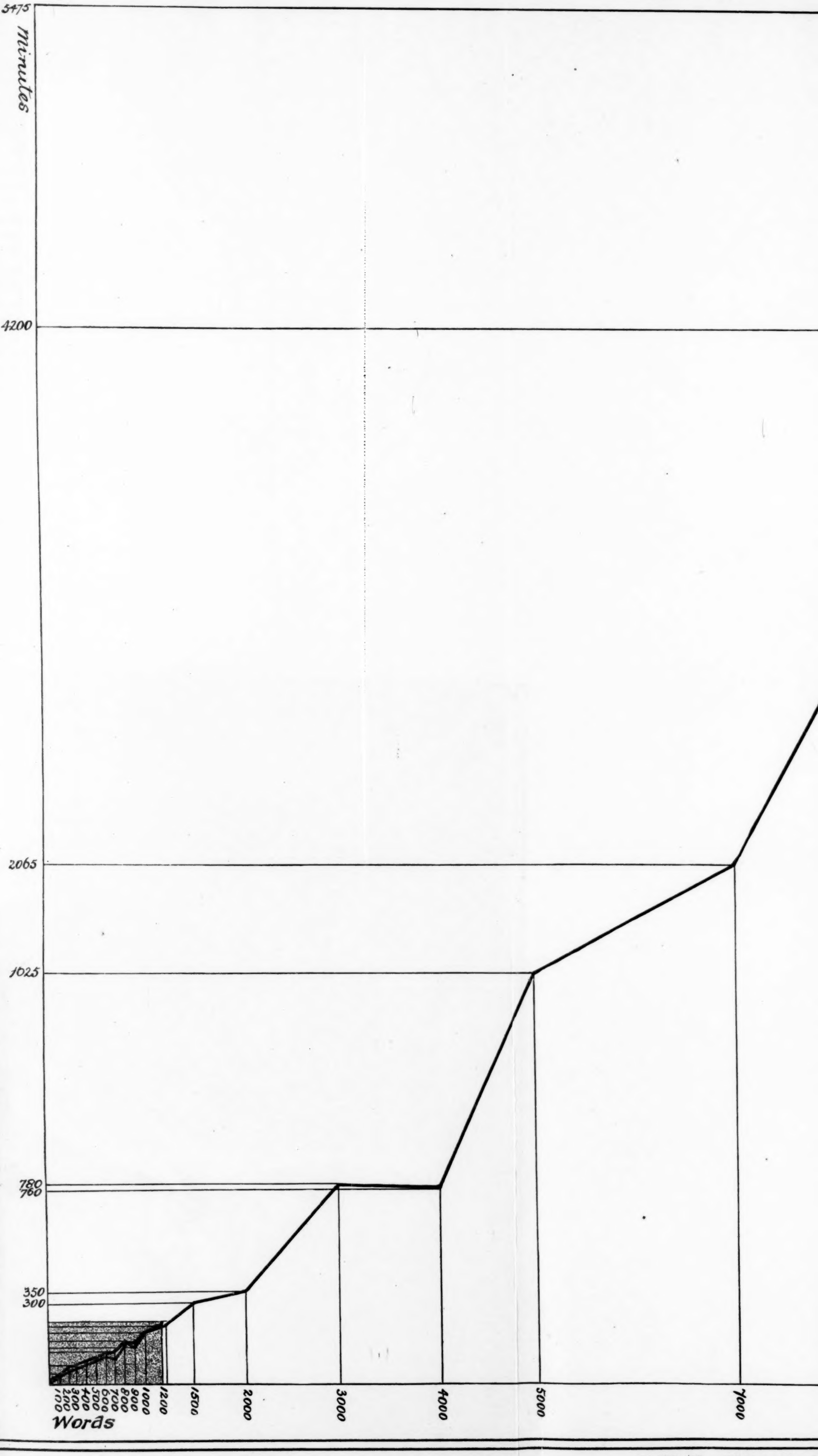
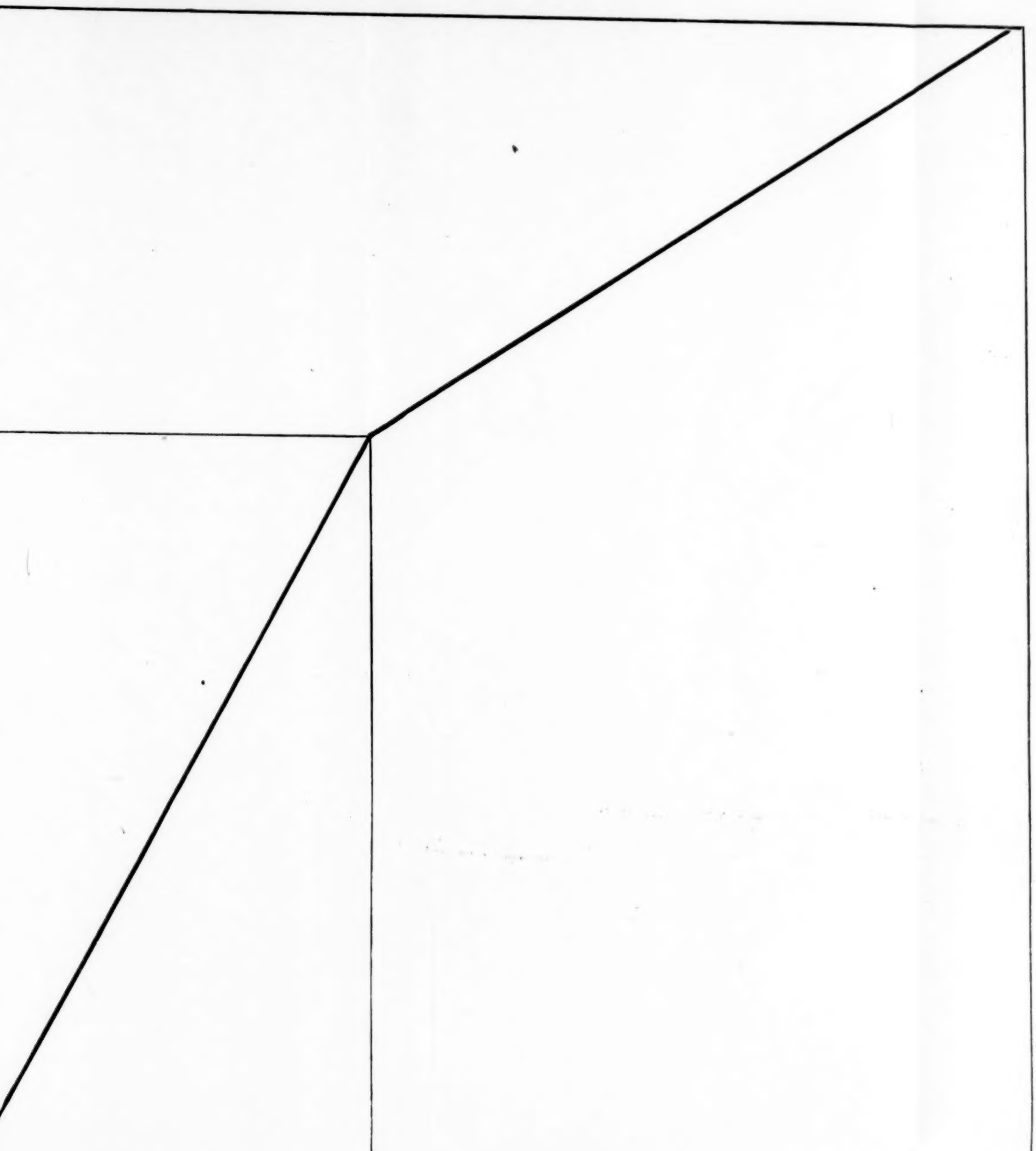


PLATE VIIa. **PROSE.** The sh
Table VII and contains "
methods. The remainder o
continued up to 15,000 word



1500 Words took 300 minutes (7½ x 40 = 300)
2000 " " 350 " (10 x 35 = 350)
3000 " " 780 " (15 x 52 = 780)
4000 " " 760 " (20 x 38 = 760)
5000 " " 1625 " (25 x 65 = 1625)
7000 " " 2065 " (35 x 59 = 2065)
10000 " " 4200 " (50 x 84 = 4200)
15000 " " 5475 " (75 x 73 = 5475)

SE. The shaded portion in the lower left corner is a miniature of contains "curves" both for the *continuous* and the *once-per-day* emainder of the plate shows the "once-per-day" method (in black) 15,000 words.

sentences are short and that one sentence has very frequently but little logical connection with what has preceded. Personal interest in each author and his subject matter is here of such importance that this factor must be taken into consideration. This, however, was one reason for using the different authors.

Here, as in the experiment with nonsense syllables and poetry, the digits were read in the morning before breakfast and the prose in the evening. No passage was started until the one then in hand was finished.[6] Not only were no other memory experiments allowed, but ordinary reading was abstained from for a period of *at least* one half an hour both before and after the reading of the passage. Since, with the "once-per-day" method, only one reading was allowed each day, the actual time taken per day was very short. Where, however, the passage was memorized in one sitting, the time in the case of the longer passages was frequently very long, e. g., that for the 1500 word passage being nearly two hours. Passages longer than this were not attempted, except by the divided time method, which method was continued up to a passage of 15,000 words.

Space permits neither a detailed statement and explanation of the facts shown in the various plates and tables nor the various psychological conclusions that might be deduced therefrom. To a certain extent, however, these are self evident upon comparing the curves of the different materials with each other,—and again comparing the same materials as memorized by the two different methods. Take, e. g., Plate 8 with its tables. It will be seen that the passage of 500 words was memorized in as few days as the 250 word passage—nay, it was even one day less. But now, as the passage is twice as long, the *total* time consumed was twice as great and, therefore, the time taken varies, approximately, directly as the length of the passage. The same relation holds true for the digits and nonsense syllables but not to the same extent, for the number of days needed for 200 nonsense syllables is con-

[6] It should be mentioned that in the attempted reproductions, one error was allowed for every fifty nonsense syllables or digits. In the case of the poetry one "help" (but never more than one) was allowed for every three stanzas, e. g., for the ten-stanza passage three "helps" were allowed. In the case of the prose one mistake (of one word) was allowed for every 100 words.

siderably greater than that needed for 20. By the "one-reading-per-day" method, however, it is evident that a *long* passage (or set of nonsense syllables) is learned in nearly as few days as a short passage. Referring again to Plate 8. We have noted that the 500-word passage was memorized in as few days as the 250-word passage and that, therefore, the total time varied directly as the length of the passage. Looking at Plate 7, however, (which shows the curve for the "continuous" method) we observe, that, whereas the 100-word passage was memorized in 9 minutes, the 500-word passage took 52 minutes,—in other words, multiplying the passage by five, multiplies the time by six.

The red "curve" on Plates 3 and 7 show the amount of time spent on the various passages by the "continuous" method. The black curve shows the total time spent in reading similar passages by the "once-per-day" method,—the reading having been done at the rate of five minutes per 1000 words. A comparison of the two curves would show that so far as poetry and prose are concerned, one method is as economical as the other, i. e., economical as far as *time spent* is concerned for the tenacity of impression is, of course, much greater by the "once-per-day" method.

When we examine Plate 5, however, which shows two similar curves for digits we find that the "once-per-day" method is considerably more economical. The same is seen in the plate for nonsense syllables—material which, like digits, is memorized in my own case by motor associations.

As before said, Plate 3 shows (in red) the total time taken to learn by the "continuous" method the various passages of poetry ranging in size from one stanza to 100 stanzas, i. e., from 25 words to 2500 words. On the plate the *ordinates* represent the number of stanzas; the *abscissas,* the number of minutes needed. The average number of words in each stanza is about 25, except those printed in red, which average 40 words the stanza.

Plates 4 and 5 have already been touched on. It will be seen that here, as in the case of nonsense syllables, the total time taken by the "once-per-day" method is much less than is that by the "continuous" method.

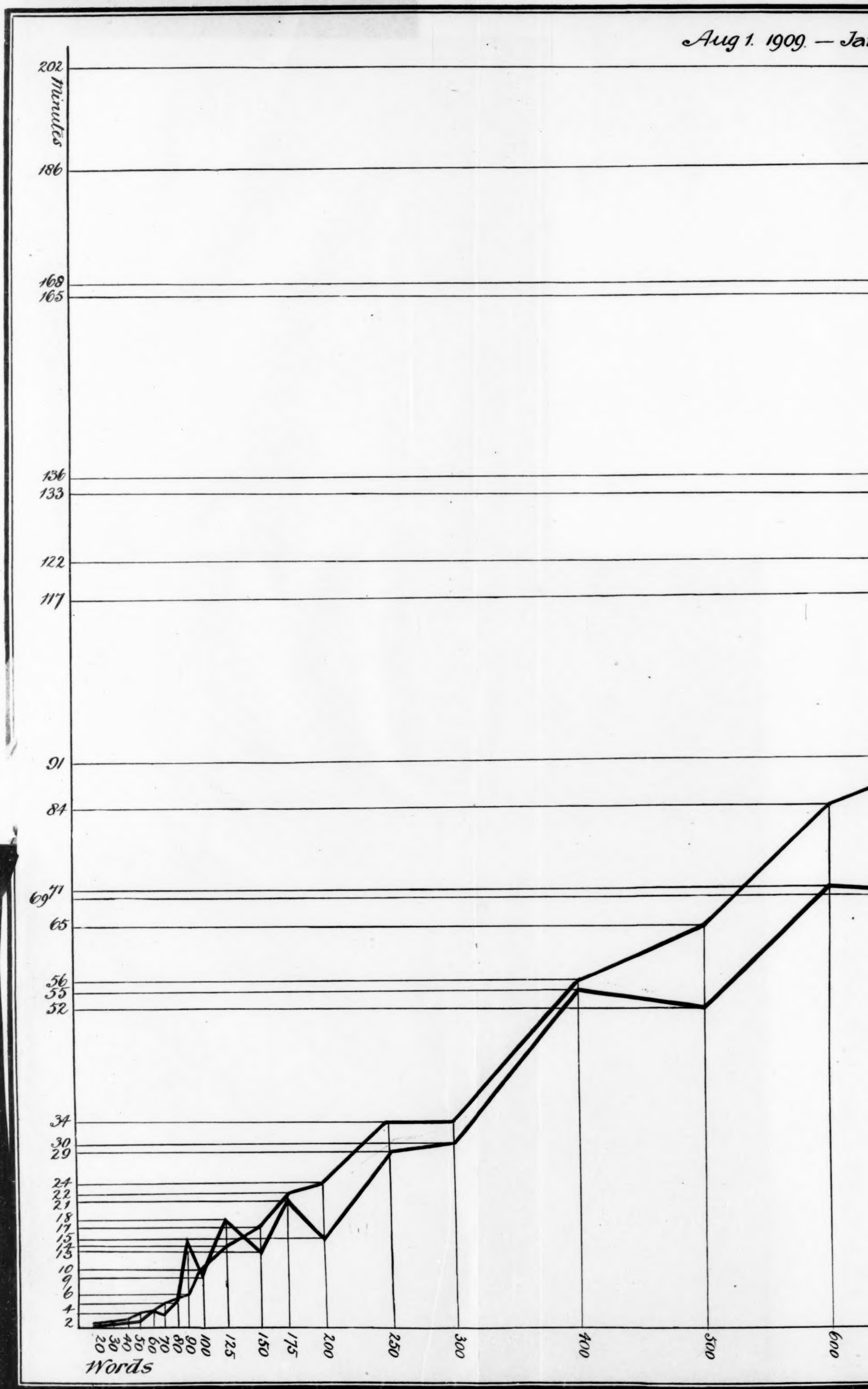
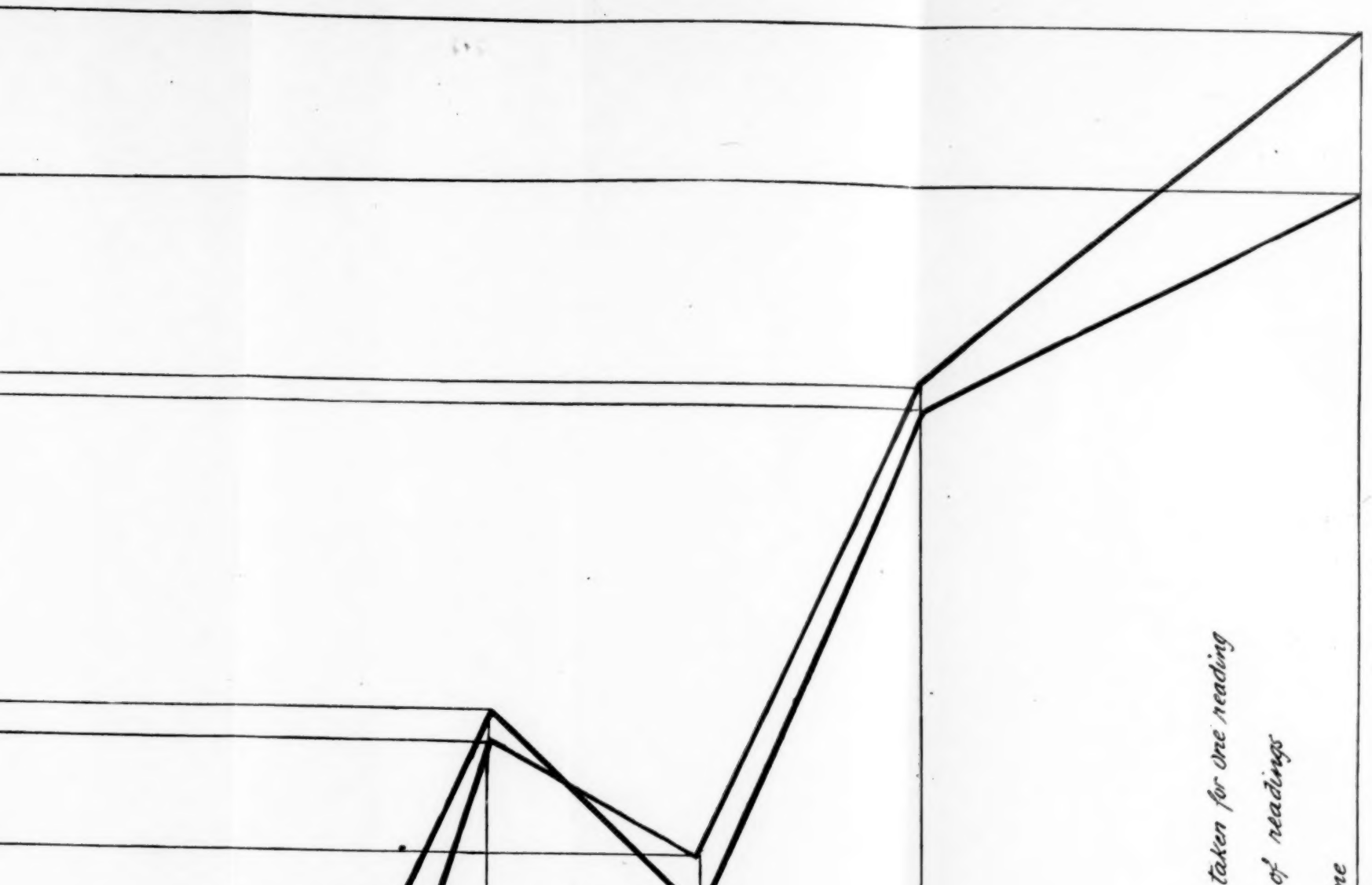


PLATE VII. PROSE. The black curve shows t
method, at the rate of 5 minutes per 1000 wo
15 to 1200 words. Its continuation is shown o
is shown in red.



	"Continuous" Method			"Once per day" Method				
							Minutes taken for one reading	Number of readings	Total time
15	Words took	1/2	Min	15	Words took	3/10	Min	(3/10 × 1 | = 3/20)
20	" "	1/6	"	20	" "	1/10	"	(1/10 × 1 | = 1/10)
25	" "	1/4	"	25	" "	1/8	"	(1/8 × 1 | = 1/8)
30	" "	3/4	"	30	" "	1/2	"	(3/20 × 3 | = 1/2)
35	" "	1 1/2	"	35	" "	1	"	(7/40 × 5 | = 1)
40	" "	2	"	40	" "	1 1/2	"	(1/5 × 7 | = 1 1/2)
50	" "	3	"	50	" "	2 1/4	"	(1/4 × 9 | = 2 1/4)
60	" "	4	"	60	" "	3	"	(3/10 × 9 | = 3)
70	" "	3	"	70	" "	5	"	(7/20 × 14 | = 5)
80	" "	5	"	80	" "	4 1/2	"	(2/5 × 11 | = 4 1/2)
90	" "	15	"	90	" "	5 1/2	"	(9/20 × 12 | = 5 1/2)
100	" "	9	"	100	" "	9	"	(1/2 × 18 | = 9)
125	" "	18	"	125	" "	14	"	(5/8 × 23 | = 14)
150	" "	13	"	150	" "	17	"	(3/4 × 22 | = 17)
175	" "	21	"	175	" "	22	"	(7/8 × 25 | = 22)
200	" "	15	"	200	" "	24	"	(1 × 24 | = 24)
250	" "	29	"	250	" "	34	"	(1 1/4 × 27 | = 34)
300	" "	30	"	300	" "	36	"	(1 1/2 × 24 | = 36)
400	" "	53	"	400	" "	56	"	(2 × 28 | = 56)
500	" "	52	"	500	" "	65	"	(2 1/2 × 26 | = 65)
600	" "	71	"	600	" "	84	"	(3 × 28 | = 84)
700	" "	69	"	700	" "	91	"	(3 1/2 × 26 | = 91)
800	" "	133	"	800	" "	136	"	(4 × 34 | = 136)
900	" "	122	"	900	" "	117	"	(4 1/2 × 26 | = 117)
1000	" "	168	"	1000	" "	165	"	(5 × 33 | = 165)
1200	" "	202	"	1200	" "	186	"	(6 × 31 | = 186)

600 700 800 900 1000 1200

rve shows the total time spent by the "once-per-day" per 1000 words, for passages of prose ranging from n is shown on Plate VIIa. The "continuous" method

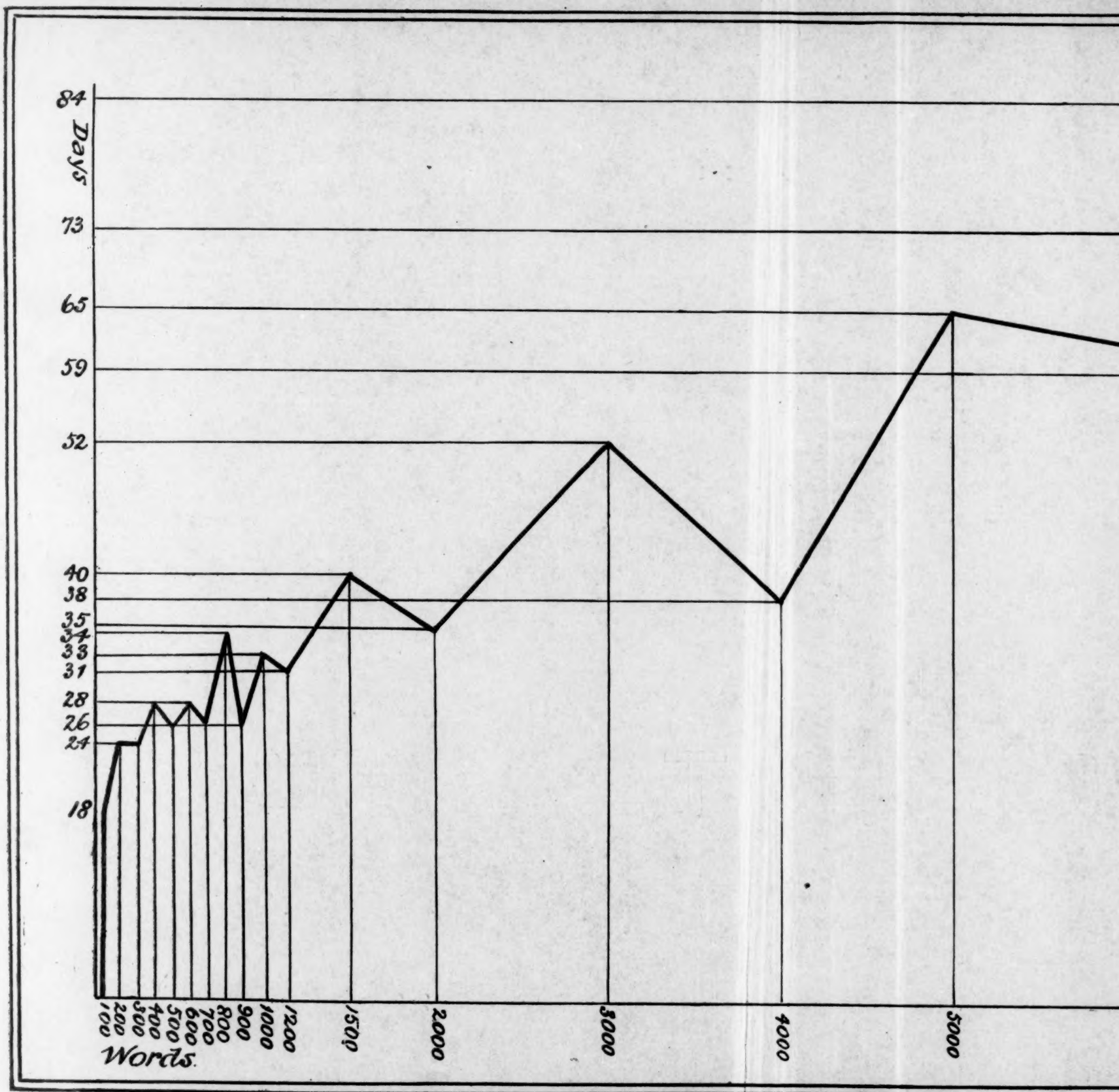
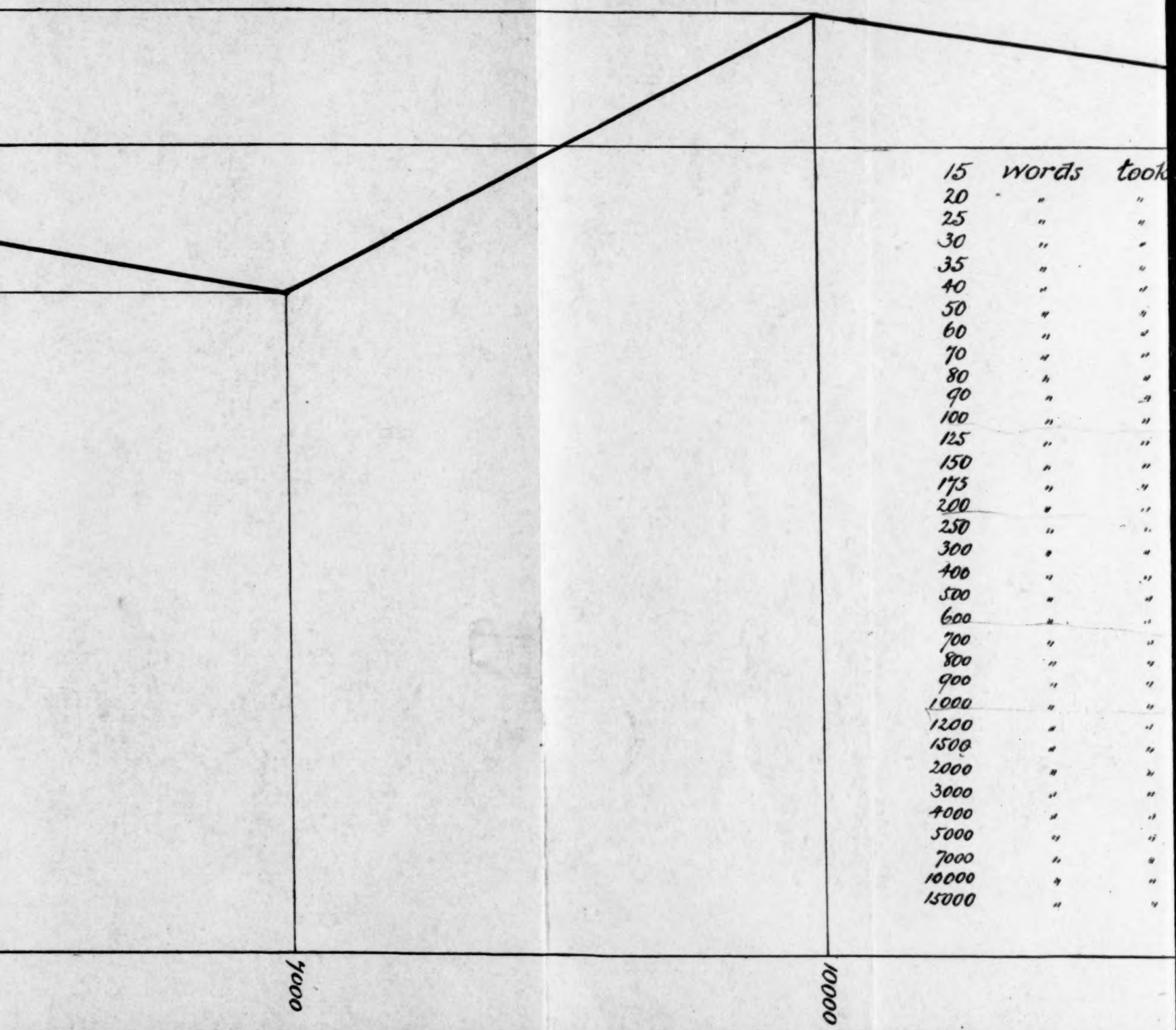


PLATE VIII. F
readings nec



TE VIII. **PROSE.** "Once-per-day" method. The "curve" shows the number of readings necessary to memorize passages of prose ranging from 15 to 15,000 words.

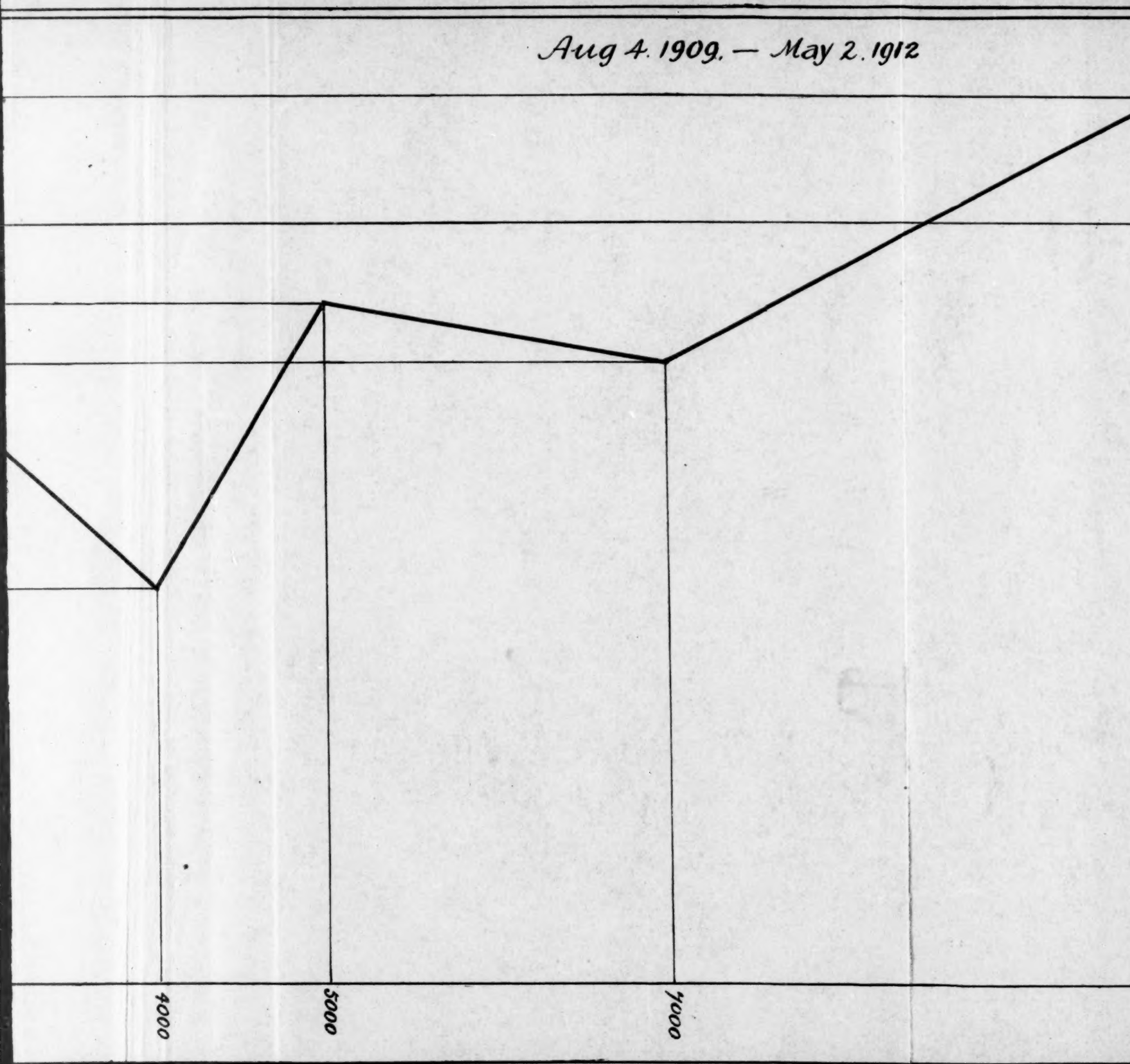
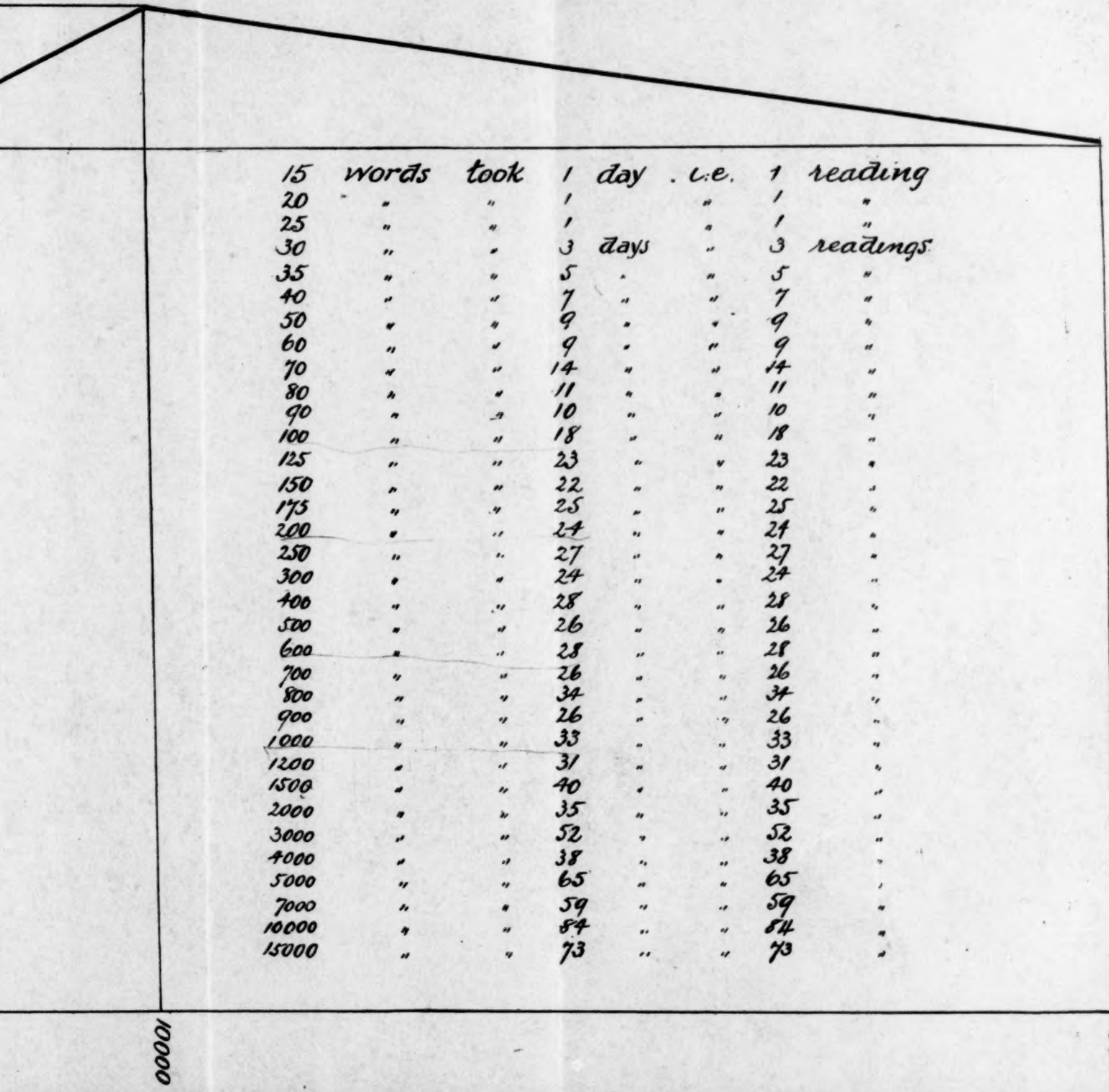


PLATE VIII. PROSE. "Once-per-day" method. The "curve" shows the number of readings necessary to memorize passages of prose ranging from 15 to 15,000 words.



15	words	took	1	day	i.e.	1	reading
20	"	"	1		"	1	"
25	"	"	1		"	1	"
30	"	"	3	days	"	3	readings
35	"	"	5	"	"	5	"
40	"	"	7	"	"	7	"
50	"	"	9	"	"	9	"
60	"	"	9	"	"	9	"
70	"	"	14	"	"	14	"
80	"	"	11	"	"	11	"
90	"	"	10	"	"	10	"
100	"	"	18	"	"	18	"
125	"	"	23	"	"	23	"
150	"	"	22	"	"	22	"
175	"	"	25	"	"	25	"
200	"	"	24	"	"	24	"
250	"	"	27	"	"	27	"
300	"	"	24	"	"	24	"
400	"	"	28	"	"	28	"
500	"	"	26	"	"	26	"
600	"	"	28	"	"	28	"
700	"	"	26	"	"	26	"
800	"	"	34	"	"	34	"
900	"	"	26	"	"	26	"
1000	"	"	33	"	"	33	"
1200	"	"	31	"	"	31	"
1500	"	"	40	"	"	40	"
2000	"	"	35	"	"	35	"
3000	"	"	52	"	"	52	"
4000	"	"	38	"	"	38	"
5000	"	"	65	"	"	65	"
7000	"	"	59	"	"	59	"
10000	"	"	84	"	"	84	"
15000	"	"	73	"	"	73	"

10000

1500

umber of
00 words.

The plates show that the total time taken by the "once-per-day" method is,—for the poetry and prose, nearly always as long as by the "continuous" method. For digits and nonsense syllables, however, i. e., material in which there is but little logical connection, there is a considerable saving of time by the "once-per-day" method. It may be said by way of objection that this is due to a more or less constant reviewing, possibly unconscious, between the various readings. This is, of course, possible, but even if so does not materially alter the conclusions that may be drawn from the curves.

As we have just said, the time by the "once-per-day" method varies approximately as the length of the material. When, however, we turn to the "continuous" method, we find that this relation holds only for the shorter passages. As soon as the passage becomes too long for the mind to grasp it as a whole, the time mounts up rapidly, as shown, e. g., on Plate 7. "This is much more strikingly shown when we examine the curve obtained for the digits. Here we see that although it took only 5 minutes to learn 24 digits, it took 2 hours and 34 minutes to learn 200—more than 31 times as long instead of 8. In short it is obvious that the "once-per-day" method is—to say nothing of giving a far superior retention—far more economical than the "continuous" method. This is especially so for material memorized by motor associations such as nonsense syllables or digits."[7]

[7] *The Relation of the Length of Material to Time Taken for Learning*, D. O. LYON, Journal of Philosophy, Psychology and Scientific Methods, Vol. IX, No. 14.

(*Concluded in the March number.*)

COMMUNICATIONS AND DISCUSSIONS.

THE EFFICIENCY OF GRAMMAR-GRADE PUPILS IN REASONING TESTS IN ARITHMETIC AT DIFFERENT PERIODS OF THE SCHOOL DAY.[1]

During the session 1911-12 the author gave to forty classes in New York City ten-minute tests in the fundamental operations in Arithmetic at four periods of a two-session school day. The results were compared as to quantity and quality in order to suggest the relative efficiency at these periods.[2] In February and March, 1913, twenty-five minute tests in the fundamental operations were given to sixteen classes in Lynchburg, Va., at two periods of a one-session day, and the results were compared with conclusions similar to those from the New York tests.[3] The present paper reports an experiment with twelve-minute tests in reasoning problems in Arithmetic given to sixteen classes in the Intermediate School in Roanoke, Va., at two periods of a one-session day.

Although rapid computation requires a continued alertness on the part of grammar-grade pupils, which can well be considered indicative of hygienic efficiency for other lines of school work, it must be granted that reasoning problems in Arithmetic of similar grade involve processes and effort more generally needed in meeting school requirements. In order to carry out in the third experiment the methods of the other two, it was necessary to use two reasoning tests that could be graded accurately and would be approximately equal in difficulty. The tests selected were Forms 1 and 3 of the Courtis Standard Test No. 8, since Mr. Courtis had proved by his very wide experience that these tests were as nearly equal as any so far made. They were given and scored according to the Courtis method, the number of examples done and the number right being

[1]Read at the Atlanta meeting of the American Association for the Advancement of Science.

[2]Report published as a monograph: "A Study of Mental Fatigue in Relation to the Daily School Program," 1913, pp. 28.

[3]Report published in the *Psychological Clinic*, April, 1913: "A Second Study of Mental Fatigue in Relation to the Daily School Program."

calculated from the figures in the "Answer" column. The non-measureable elements in this gross method were mainly neutralized in the comparison of morning and afternoon work.

On Monday, December 8, Form 2 of Test No. 8 was given as a preliminary test to all sixteen classes in order to acquaint them with the matter and method of the succeeding tests; but the papers were not scored. By trying ten, fifteen, and twelve minutes as the time limit for this preliminary test, the twelve-minute limit was found to be most suitable for the classes concerned. For the succeeding tests the classes were divided into groups of four, each group containing a 7A, a 7B, a 6A, and a 6B class of equal rank with other classes of the same half-grade. As the classes in a group were tested in rapid succession, about sixty-five minutes were required for a group—from 9:25 to 10:30 in the morning or from 12:50 to 1:55 in the afternoon. The first test was given to Group 1 on Tuesday morning, to Group 2 on Tuesday afternoon, to Group 3 on Wednesday morning, and to Group 4 on Wednesday afternoon. The second test was given to Group 2 on Thursday morning, to Group 1 on Thursday afternoon, to Group 4 on Friday morning, and to Group 3 on Friday afternoon. Thus each class was tested in the morning and in the afternoon; and each test was given in the morning and in the afternoon to the same number of classes of relatively equal rank. By this method the practice effect in the second test was neutralized by approximately equal representation in the morning and in the afternoon results. To complete this neutralization the classes in Groups 1 and 2 were tested in descending order (7A, 7B, 6A, 6B) and the classes in Groups 3 and 4 were tested in ascending order (6B, 6A, 7B, 7A).

A teacher generally remained in the room during a test but assisted me only in distributing and collecting the papers. The children enjoyed the tests, which they thought were only for correctness and speed. They did not know the time limit for the work; and the few that finished early spent the extra time in looking over their papers. Where children were absent from one test or where they did not follow important directions, their papers were thrown out.

The hygienic conditions in the new school building were unusually good, but there had been no medical inspection of the children. Opening exercises were held in each room from 9:00 to 9:20, recess was given from 12:15 to 12:35, and the first bell for dismissal was

rung at 2:15. The only recess did not give much invigoration, because the boys' playground was small and most girls remained indoors in spite of beautiful weather. Some pupils ate a light lunch at recess, but nearly all had dinner at home after school. The departmental system of instruction prevailed throughout with half-hour recitation periods. All classes included both boys and girls, the total represented in my results being 212 boys and 255 girls. The average age was 14.18 years.

After the papers were scored, the averages of the number of examples done and the number right in the morning and in the afternoon tests were made for each class. Then general averages were made for the sixteen classes combined, and the morning and the afternoon results were compared. *The number of examples done in the afternoon was* 0.68 *per cent greater than in the morning; the per cent of examples right in the afternoon was* 3.22 *per cent less than in the morning.* These per cents are strikingly similar to those from the Lynchburg and New York (average of two afternoon tests) experiments, where the increase in quantity in the afternoon was 1.18 and 1.78 per cent respectively and the decrease in quality 3.08 and 5.61 per cent respectively. As was shown by the New York results, the decrease in quality would be less by a detailed method of grading.

TOTAL RESULTS.

		Morning.			Afternoon.		
Class.	Pupils.	Test.	Examples.	Right.	Test.	Examples.	Right.
7A1	26	1	5.96	4.50	2	6.73	5.27
7B1	30	1	5.60	4.20	2	5.97	4.77
6A1	31	1	4.87	3.81	2	5.45	4.23
6B1	29	1	4.83	3.76	2	5.07	3.97
7A2	32	2	6.84	5.44	1	5.78	4.00
7B2	35	2	6.23	5.09	1	5.97	4.31
6A2	27	2	6.37	4.81	1	5.93	4.19
6B2	25	2	5.88	4.56	1	4.96	3.00
6B3	24	1	4.96	2.71	2	5.33	3.58
6A3	26	1	5.04	3.27	2	6.42	4.19
7B3	35	1	4.74	3.34	2	6.06	4.51
7A3	33	1	6.64	4.70	2	7.48	5.27
6B4	28	2	6.00	4.43	1	5.39	3.54
6A4	29	2	5.79	3.83	1	5.10	3.31
7B4	28	2	6.82	4.93	1	5.96	4.00
7A4	29	2	7.00	5.55	1	6.72	5.14
16	467		5.85	4.31		5.89	4.20

Relative number done	100.00	100.68
Per cent. right	73.68	71.31
Relative per cent. right	100.00	96.78

The practice effect was calculated by re-arranging the class averages according to first or second test rather than according to morning and afternoon, thus neutralizing for the most part the decrease in efficiency in the afternoon. The sixteen classes showed in the second test an average increase of 12.43 per cent in quantity and an average increase of 7.16 per cent in quality. This large practice effect was mainly due to the difficulty the children had at first in disregarding unnecessary figures in some of the examples.

The final conclusion to be drawn from this experiment in Roanoke with reasoning tests in Arithmetic, as well as from those in Lynchburg and New York with the fundamental operations, is that normal, healthy children of the grammar grades, in a hygienic school environment, can meet the requirements of the usual daily school program without injury to themselves or their work.

The seventh grade showed more relative efficiency in the afternoon than did the sixth grade, probably on account of better discipline in the former. The seventh grade had an increase of 1.61 per cent in quantity in the afternoon and a decrease of 2.82 per cent in quality; the sixth grade had a decrease of 0.04 per cent in quantity and a decrease of 3.67 per cent in quality.

Complete tables of class and general averages were made for the girls and for the boys, showing the greater relative efficiency of the former in the afternoon. The girls had an increase of 1.78 per cent in quantity in the afternoon and a decrease of 2.48 per cent in quality; the boys a decrease of 1.30 per cent in quantity and a decrease of 3.76 per cent in quality.

W. H. Heck.

University of Virginia.

INFORMAL CONFERENCE ON THE BINET-SIMON SCALE: SOME SUGGESTIONS AND RECOMMENDATIONS.

During the International Congress for School Hygiene, recently held at Buffalo, the undersigned members of the Congress, who have had more or less experience in the use of the Binet tests and who are particularly anxious to devise and encourage some form of procedure that shall render the results of different investigators strictly comparable, held two informal meetings in an endeavor to further this end. At these meetings the questions that follow were set forth for consideration and were discussed, one by one, until agreement

was reached or until it was 'agreed to disagree.' These questions and the answers reached to them are now published with the hope that they may be of service to others who are using the Binet scale. We respectfully urge all American and English investigators to give their adherence to our proposals during their work for the next year or so, but at the same time we disclaim any intention to impose our views upon other workers or to stifle progress in mental testing. We would point out that it will not be difficult for any experimenter to follow the plan we suggest and at the same time to supplement or extend his investigation to any degree or in any way desired. It is hoped that by thus adhering to a standard form of procedure, with supplementary trial variations, these recommendations may later on be reviewed in the light of data secured by various investigators.

1. Of the various Binet scales and editions of his scales now on the market, which one should be employed?

We recommend that for the present all experimenters employ the translation of the 1911 scale prepared by Dr. Clara H. Town,[1] but with the following provisions:

(*a*) That the same uncolored pictures be used that Binet prescribed.

(*b*) That the word *'defender'* be tried in the test for riming. Sample rimes: *pretender, contender, suspender.*

[We recommend this word in place of *obey* because the French word *obeir* is tri-syllabic. Again, the explanation given in the Town instructions in this question must be altered, because in the English language words that rime must have correspondence of sound in all syllables from the accented syllable to the end of the word.[2]]

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[1]No one of us believes that this translation is ideal, nor that even an ideal translation would form the best possible scale for American children. But were one to pick and choose from the various scales on the market, the resulting eclectic edition, however satisfactory to its constructor, would only increase the confusion that now exists. The Town translation appears to be the nearest approach, of anything generally available in English, to Binet's own last word on his method.

[2]Since the conference was held there has been further correspondence between the participants with regard to this riming test. The real difficulty is that a rime in French is quite different from a rime in English. To take this test over into English we should, therefore, give up the idea of finding rimes, and substitute therefor a test in finding words that have the same ending as a given word. We have made a few trials with the ending *tion, ment, ject, ness* and *tain*, after giving *button, Boston* and *making, reading*, as samples. Adults give 3 to 15 words in one minute for these endings, but we have not yet been able to standardize this test with children.

(*c*) That in the first test at 9 years, 6 cents be used instead of 4 cents (or of 9 cents, Goddard) in making change from a quarter [because this affords a degree of difficulty nearer that of the original Binet test (taking four sous from 1 fr.)].

(*d*) That in the 3d test, 9th year (knowing money), the following coins be shown, but not in regular order:—cent, nickel, dime, quarter, half-dollar. The child should then be *shown* a dollar bill, and, if it is known, should be asked what bills there *are* larger than one dollar. If he answers—"two, three, four, five," etc., he is to be asked whether he has seen a three or a four dollar bill, and the test is to be considered as passed if he denies having seen the bills that do not exist.

[We recommend this procedure because the silver dollar is not often seen by children in the eastern states, because it is often inconvenient to secure five and ten dollar bills, and because if these are *shown,* their denomination is too plainly indicated upon them.]

2. Is it necessary to secure so-called 'normal' children to standardize these tests and what is the criterion for normality?

A test may be considered normal for a given age if it can be passed by 75 per cent. of the non-selected school children of that age.

3. How many children of a given age must actually be tested to be sure that a test is standard for that age?

It is impossible to state precisely, but enough cases must be tried so that further data from groups of non-selected children do not appreciably affect the distribution. The number needed will vary according as the test is sharply or only slightly diagnostic for a given age.

4. Should we have norms established for each half-year in the early years?

Yes, it would be desirable theoretically and probably practically, though we are not in agreement upon the amount of practical value that would result.

5. How is it best to designate a chronological and mental age?

We agree to use each number as at present popularly used, *i. e.*, 5 years means between the fifth and the sixth birthday, averaging 5.5 years.[1] We further recommend that, whenever mental and chron-

[1]Some of us believe that the designation of age by the nearest birthday is really to be preferred.

ological ages are in any danger of confusion, the mental age be expressed in Roman, the chronological in Arabic characters.

6. What should be the 'range' used in testing, *i. e.*, how far down and how far up the scale should the trials extend?

Trials should be made downward to include at least one year below the basal age, and upward to include at least two years beyond the last age in which any test is passed. Both these limits should be exceeded if the child shows eccentricities or irregularities in response that might indicate epilepsy, insanity or any other unusual mental disturbance.

7. Should the scale be divided, in the upper years at least, to furnish separate standards or separate tests for the two sexes?

We do not know, and recommend this as a subject for investigation.

8. Is it possible to devise tests and lay down standards by single-year steps for the ages above 12?

We disagree and recommend special investigations looking toward the extension of the scale above its present limits.

9. Is it theoretically and practically desirable to increase the number of tests assigned to each year,—perhaps to ten tests?

The Binet scale is designed for rapid testing, so that it is convenient to keep the number of tests at 5 (or perhaps 6 in view of the division of the year into 12 months). It is, however, desirable to have supplementary tests: in fact, it would be desirable to have a complete supplementary scale or scales to be used interchangeably with the present scale.

10. How much value have the tests that hinge on the child's stock of information (as opposed to his capacity)?

They are of less value for diagnosis than are tests of capacity and perhaps should be replaced eventually by more direct tests of capacity.

11. What is it, after all, that the scale aims to test?

We believe that current misconceptions as to the aim of the scale should be removed. It is not intended to test the emotional or volitional nature, but primarily intelligence (judgment).

12 Does the scale provide a reliable means of diagnosing feeble-mindedness?

It does not *always* furnish a sharp, nor a positive diagnosis of feeble-mindedness: in particular,

(*a*) a mental age of 10 or above is not necessarily indicative of feeble-mindedness, regardless of how old the examinee may be, and (*b*) a young child may test almost at age and yet be feeble-minded as determined by other criteria.

13. What is native intelligence?

This question was passed by, after some debate, for lack of time.

14. Could tests of other factors than the intellectual, *e. g.*, volitional and emotional, be incorporated in the scale?

Answer given by the principle set forth in No. 9.

15. How much is the outcome of the testing influenced by the personal equation, both of the examiner and examinee?

Undoubtedly there is some influence and it may be at times a serious source of error (see Goddard, *Psychol. Bulletin,* 10: 1913, p. 76).

16. Can all the tests be freed from the personal equation of the examiner in so far as concerns the decision as to whether a test is passed or not?

Something can be done by making the directions precise and detailed, by publishing examples of satisfactory and unsatisfactory responses, and by giving every examiner adequate preliminary training.

17. Are very specific directions necessary for the proper administration of each test?

Unqualifiedly yes.

18. How much do previous environment and school training affect the outcome of the tests?

The experimental evidence thus far available is conflicting. Further investigation is needed.

19. Should the examiner follow the regular order of the printed blank?

By no means. It is well to begin with a few fairly easy tests, then to take up some harder ones, then again some easier oues. Seek variety. Follow up suggestions gained by watching the examinee as to his interests. A favorable order in beginning is first to ask the child's name, his age, and then to try the pictures.

We would respectfully urge experimenters to adopt our recommendations for the sake of intercomparability of results and that

all variations from this procedure be additions, to be kept strictly separate from what we have here proposed as a standard method.

J. C. BELL, University of Texas.
C. S. BERRY, University of Michigan.
W. S. CORNELL, Director Medical Inspection, Philadelphia.
E. A. DOLL, Training School, Vineland, N. J.
J. E. W. WALLIN, University of Pittsburgh.
G. M. WHIPPLE, Cornell University.

EDUCATIONAL PSYCHOLOGY AT THE NEW HAVEN MEETING OF THE AMERICAN PSYCHOLOGICAL ASSOCIATION.

The program of the New Haven meeting contained very much less of interest for the educational psychologist than did that of the Cleveland meeting of last year. The session for mental tests was shared with applied psychology and the session for education was shared with comparative psychology. The following papers and features, however, deserve mention.

In the apparatus exhibit, G. M. Whipple, Cornell University, demonstrated a new arrangement for the "form board" test. The forms fitted flush with the surface so that the subject could not detect them by passing his hands over the surface. The holes for the forms were cut out of separate blocks rather than out of the frame itself. These blocks could then be shifted about in the frame as a control for position factors. Finally the entire apparatus could be folded up and carried conveniently. Whipple's assistant has arranged the number cancellation test in such a manner that the numbers fall into particular spatial systems. A piece of paper with holes punched appropriately may be laid over the record sheet so that all numbers of one kind appear through the holes. If the paper is turned over in another manner, all numbers of another kind appear, etc. This furnishes a great aid in checking up results. H. C. Warren, Princeton University, presented an apparatus for the separation of the factors of speed and accuracy in the tapping test. J. W. Hayes, University of Chicago, demonstrated three very ingenious problem boxes. Each box could be easily varied in complexity by removing certain levers. Unless the subject worked the levers and buttons in the proper order, an automatic locking device prevented the opening of the box.

At the secretary's request, a special exhibit was arranged where members of the association might file syllabi and other outlines in use with psychology classes. Of these, those by Whipple, Thorndike and Woodworth were the most finished and complete. The only general statement that can be given is that parallel reading and experimentation are being emphasized. Mental tests and group experiments are being introduced. The exhibition suffered severely—in the opinion of the present writer—because the syllabi were not accompanied by supplementary data stating the conditions under which the courses were given. The material might then have been classified on this basis, thus making possible a ready comparison of the different methods of teaching.

The following papers were of general interest: Ellsworth Faris, *Punitive Justice and the Social Consciousness;* W. D. Scott, Northwestern University, *Group Judgments;* J. F. Shepard, University of Michigan, *Types of Learning in Animals and Man;* G. Stanley Hall, Clark University, *The Freudian Idea of Ambivalence;* and Mabel R. Fernald, Chicago Teachers College, *An Investigation of Color Preferences in School Children.* E. A. Kirkpatrick, Fitchburg Normal School, reported a study of memorizing vs. incidental learning. (The question was raised, however, whether or not the learning was incidental.) The following is a quotation from the author's abstract: "The results in this preliminary experiment suggest that the traditional practise of learning and drilling on facts such as the multiplication table, then using them afterwards, is wasteful as well as wearisome." H. L. Hollingworth, Columbia University, in studies on judgments of evaluation, detected sex differences. The men agreed in both their likes and dislikes. The women agreed in their dislikes, but not in their likes. R. S. Woodworth, Columbia University, in a study of "quick learning, quick forgetting," found exceptions to the above rule. The method was that of paired associates; the material, English-Italian vocabulary. Aids in learning were great factors in the retention. The investigator leaned toward the belief that there was no correlation between quickness of learning and amount retained. Lastly, the paper by H. H. Goddard, Vineland, N. J., on the inheritance of feeble-mindedness may be mentioned. A greater percentage of affirmative cases was found in the later (5-11) mental ages. It was suggested that this was due to the greater frequency of marriage during this pe-

riod. (During the discussion, the criticism was made that the investigator had not clearly differentiated the accidental cases.)

At the session on mental tests, W. S. Cornell, Philadelphia, reported data on the influence of race, color, nativity and truancy on the Binet tests. Negative results were obtained due, probably, as the speaker suggested, to the advanced ages of the subjects. A. J. Rosanoff, King's Park, N. Y., advocatd a correlation of tests with specific, readily measurable segments of the environment, such as at present are offered only in the field of systematic education. It was found that the number of appropriate reactions was correlated with the degree of education. Where the degree of education was a constant, much individual variation was present. R. M. Yerkes, Harvard University, was prevented by illness from reporting upon "Mental Measurement: a Substitute for the Binet Scale."

Following the reading of these papers, a round table discussion on mental tests for college students was held. J. P. Porter, Clark University, suggested that tests be devised to aid the college dean in determining a student's fitness to remain in school. This type of work is being started at Clark University. Princeton, Dartmouth, Cornell and Chicago—I believe—all report tests of a somewhat similar nature. Two points of view are involved, the practical and the scientific. It is difficult to say whether these are or are not mutually compatible ends. Some pessimism was manifest with respect to the apparent development of mental tests. This attitude is not wholly justified because, although the tests cannot be expected to exhaust the richness of the subject's character, they can nevertheless give a better insight into certain measureable features than has hitherto been obtainable.

WALTER S. HUNTER.

University of Texas.

EDUCATIONAL PSYCHOLOGY AT THE ATLANTA MEETINGS.

The meeting of the American Association for the Advancement of Science at Atlanta, December 29-January 2, was especially well attended by southern men and women who are interested in educational problems. Almost every university and many of the leading colleges in the south had representatives in attendance. Section H

(Anthropology and Psychology), Section L (Education) and "The Southern Society for Philosophy and Psychology" each had programs of value to the scientific study of education.

The paper prepared by B. T. Baldwin, Swarthmore College, and read by E. E. Rall, University of Tennessee, on "The Present Status of the Honor System in American Colleges and Universities" presented facts from about forty institutions. The data showed great variations among these institutions in regard to both the administration and application of the system. Many of the larger universities have recently established the honor system in part or in whole, and report in nearly every case that it is growing in favor. Those institutions in which it has been established longest and in which it has really been tested are its strongest adherents. (See the January number of this JOURNAL.)

In the field of tests two papers were read. "A General Intelligence Test" by L. R. Geissler, University of Georgia, and "A Comparison of White and Colored School Children Measured by the Binet Scale of Intelligence" by Josiah Morse, University of South Carolina. Geissler's test consists of one hundred words divided into two lists of fifty each. The subject is shown a word from the first list and a certain time is allowed for the selection of a word from the second list which readily "pairs" with the first word. The reasons for the selection of the word are also required. Morse's results showed a very marked difference between the two types of children. It has been supposed by some that up to a certain period in their development negro children have as much ability for making progress in school work as white children, but according to this investigation white children of every age are superior to the colored children. The accuracy of the results was tested by selecting white children from two distinct social classes. This check upon the results emphasized their correctness, for even the lower class of white children ranked above the negro children in the tests. In the discussion of the paper it was suggested that a further check should be made by the selection of different social classes among the negro children.

The paper read by J. C. Barnes, Maryville College, on "Correlation of Physical and Mental Measurements" presented data from one hundred college students. Four measurements were used, height, weight, lung capacity and cephalic index. The grades upon

the regular college work were used as measurements of mental ability. A casual examination of the results indicated a high degree of correlation between the factors, but when the Pierson co-efficient was found the correlation was very small. In the discussion following the paper Prof. Cattell suggested that the computation of the probable error would have added much to the value of the results.

David Spence Hill, in his "Notes from the Department of Educational Research, Public Schools, New Orleans," indicated the present status of the department, the problems now under investigation and some of those which will be attacked in the future. One of the most interesting things in the report was the statement that the building of a very large and expensive vocational high school had been postponed until investigations could be made by the research department concerning such work. It seems evident that there is a genuine demand in this great city for the kind of work which Dr. Hill is doing, and the school authorities seem disposed to recognize it by basing many of their official acts upon results obtained by his department.

C. Truman Gray, University of Texas, reported an investigation upon "Pressure in the Handwriting of Children." Records have been taken from the writing of forty children, representing each of the seven grades. The principal part of the apparatus shown was a movable platform, so connected with a pneumatic transmission system that the variations in pressure on the writing surface are registered on a kymograph drum. Tables were presented to show the number of variations, the time, and the amount of pressure in grams for both separate letters and connected writing. An important point brought out in the conclusions was that one phase of the pressure co-ordinations, the number of variations, is established by the end of the third or the beginning of the fourth school year. A second point was that the establishment of a definite rhythm in the pressure does not come until much later.

Lightner Witmer, University of Pennsylvania, in his paper on "Children with Mental Defects Distinguished from Mentally Defective Children," made a strong plea for the careful study and treatment of children with one or two mental defects. He cited a number of cases from his clinic to show that such children are able after careful diagnosis and proper treatment to take a normal place in society, whereas otherwise they would only be classed with mental

defectives. His second paper was an argument for greater specialization in educational work and the division of the field into small units. Each teacher should be a specialist in his line and few transfers should be made from one field to another.

Max Meyer, University of Missouri, in his paper on "The Limit of Uniformity in the Grading of College Students by Different Teachers" stated that the lack of uniformity in grading in the University of Missouri had been reduced eighty-five per cent. This is probably as far as the effort to secure uniform grading should be carried.

The paper by Edward K. Strong, Jr., Columbia University, on "Two Factors Which Influence Economical Learning" dealt chiefly with the psychology of advertising. He showed that the laws of advertising have much in common with the laws of learning worked out by Dearborn, Pyle, and others.

A number of other papers with very suggestive titles were read, but the writer was unable to hear them. Among these were the following:—"Standards in English" by S. A. Courtis, Liggett School, Detroit; "A Study of the Efficiency of Grammar Grade Pupils in Reasoning Tests at Different Periods of the School Day," by W. H. Heck, University of Virginia (see elsewhere in this issue); and "The Correlation of School Abilities of High School Girls," by E. F. Buchner, Johns Hopkins University.

One of the strongest papers of the whole session was read by Vice-President Cattell upon "Science, Education and Democracy." His wit, his breadth of view and his scholarly presentation made it an address long to be remembered by those who heard it.

C. TRUMAN GRAY.

University of Texas.

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EDITORIAL.

RESEARCH IN PUBLIC SCHOOLS.

It is gratifying to note that the attitude of the public and of school authorities toward questions of school procedure is rapidly undergoing a change. Only a few years ago the superintendent of one of our largest school systems refused to permit an investigation of the value of physical training, requested by the direction of that department, on the ground that the public demands absolute knowledge on the part of school officers, that they are hired because they are supposed to know what ought to be done in their respective fields, and that any confession that they do not know or any attempt to discover better methods through investigation would be taken as evidence of incompetency and would result in an immediate request for retirement. Today the people themselvs are beginning to show doubt and unrest at traditional procedures, and are insisting on school inquiries, school surveys and objective standards of efficiency in all lines of school activity. The progressive superintendent is quick to take advantage of this change of attitude, and seizes every opportunity to organize the resources of his community for the bene-

fit of the schools, and to get more light upon the various aspects of school work. One of the most striking instances of this is seen in the recent report of Superintendent Joseph Marr Guinn of New Orleans. First by an arrangement with the department of education of Tulane University, and later by the establishment of a Department of Educational Research as an integral part of the public school system of New Orleans. Superintendent Guinn is endeavoring to secure for the public schools all the benefits that accrue from modern methods of educational investigation. As a result his report can be held up as a model of constructive, rational effort at determining the actual conditions of the school population, and at making such recommendations as the needs of the community seem to demand. Almost half of the report, some ninety pages, is devoted to the report of the Director of Education Research. Dr. David Spence Hill, on "Problems of Extreme Individual Differences in Children of the Public Schools." Dr. Hill gives an admirable statement of the aims and ideals of his department, presents the results of many individual studies of school children, and notes the remedies available and proposed. First, a preliminary census of exceptional children was taken by means of a questionnaire to the teachers, and on the basis of this data the children were roughly classified into five groups: A. Feeble-minded or insane children (which should not be in the public schools but in institutions). B. Backward children (not in class A). C. Exceptionally gifted children. D. Incorrigible children. E. Children of apparently good intelligence but suffering from some physical defect (as defective vision, hearing, or speech, crippled children, and epileptics). Intensive studies were then made of such individual cases as could be reached by the department. These studies included a school report, personal and family history (investigated by a social visitor), medical examination, and psychological examination. In the psychological examination anthropometric measurements of height, weight, grip, lung capacity, and head dimensions were taken, tests were made of vision and hearing, the form board and Binet tests were administered, and these were supplemented by the Healey Picture Puzzle, the "Aussage" test, and certain association and perception-motor tests. With the data from all these studies in hand a conference was then called between the laboratory staff, teachers, principal, parent and superintendent of schools, the case was discussed as frankly and tactfully

as possible, and recommendations as to treatment were made. The report presents no individual studies of exceptionally gifted children, but the director lays emphasis on the need for such studies, and it is to be hoped that the coming year will see some work done in this field. One of the valuable features of such investigations is the reflex effect that they have upon the principals and teaching staff of the school system. If the co-operation of the teachers is properly secured new vistas of study and growth are opened before them, and a new light is thrown upon many of the problems of the classroom.

J. C. B.

NOTES AND NEWS.

The National Association for the Study and Education of Exceptional Children is making an effort to raise a fund of $100,000 for the following objects: To provide scholarships for needy cases; to equip an observation clinic and laboratory; to establish courses for the training of teachers for exceptional children; to organize lecture, library and information bureaus; to publish books, blanks and test appliances which will facilitate the study of exceptional children; and to enlarge the equipment of the Association by the erection of new buildings. In the furtherance of its campaign the Association has prepared an interesting booklet setting forth the number of subnormal children in this country and the consequences of their neglect.

According to the daily press, Chicago is considering the establishment of a psychopathic laboratory in connection with the criminal branch of the Municipal Court. Mayor Harrison is reported to favor the laboratory provided a high-class expert be placed in charge. It is proposed to have $5,500 appropriated by the city and a like amount by the county.

The questionnaire appears to be still much in favor as a device for gathering opinion and information. We have received within a few days a questionnaire from Professor M. E. Haggerty, of Indiana University, on qualities which should determine a man's fitness for a professorship in a university, one from Mr. Leon A. Carley, New York University, on methods of determining and treating mental delinquency through the courts, and one from Professor Munroe Smith and Everett P. Wheeler, of New York City, on suffrage for women, including the economic, political, sociological, anthropological and psychological aspects of the problem.

Mr. Arthur MacDonald, of Washington, D. C., known for his work on "Abnormal Man," and his "Experimental Study of Washington School Children," is engaging in propaganda for the establishment

of national, state, and city laboratories for the investigation of criminal, pauper, and defective classes. He believes that the prison should be a reformatory, and the reformatory a school, and that the only way to deal effectively with the problem of the criminal is to educate him in ways of right thinking and social, instead of anti-social, living. He urges the Mayor of the City of New York to establish a bureau of moral health for the scientific study of crime and criminals in that city. This is a move in the right direction, and should be supported by all students of human behavior.

The International Faculty of Paidology, at Brussels, recently conferred for the first time the degree of Doctor of Paidological Science. The recipient of the degree was Dr. Lipska-Librach, whose thesis "On the Relations between Sensory Acuity and the Development of Intelligence" was based on an experimental study of 420 Brussels school children.

The Board of Education of New York City has appointed a special committee to study the problem of the mentally defective children in the schools. This committee recently called a conference of those especially interested in the education of feeble-minded children, and is preparing a comprehensive report on the subject.

During the summer of 1914 there will be held in Leipzig, Germany, an international exhibition of the book industry and the graphic arts. In the section of "The School and the Graphic Arts" there is to be as complete a representation as possible of the most important pedagogical periodicals of the world. This exhibit is in charge of Mr. Max Döring, managing editor of the Archiv für Pädagogik, Uhlandstr. 29, Leipzig.

Edmund B. Huey, Ph.D., died at Connell, Washington, December 30, 1913. Dr. Huey was one of the first to devote his attention to experimental studies in educational psychology in this country. As a student in Clark University he chose as his problem the study of eye movements in reading, and perfected the first practical device for accurately recording those movements. His researches in this field led to the publication of his book on "The Psychology and Pedagogy of Reading," which remains the standard work on the subject,

and has perhaps done more than any other book to familiarize teachers with scientific methods of studying educational problems. More recently the subject of mental defects engaged Dr. Huey's attention, and in order to perfect himself in this work he spent two years in Paris studying with Janet. After a year at the Lincoln State School and Colony for the Feeble-Minded, Lincoln, Ill., he went to Johns Hopkins as assistant to Dr. Adolf Meyer in the psychopathic hospital. Ill health made it necessary for him to seek the Pacific coast, and an unfortunate fire some months before his death destroyed the notes and manuscript of a book on clinical psychology, at which he had been working for many years. Dr. Huey was one of the foremost contributors to the study of feeble-mindedness in this country, and by his numerous magazine articles on the subject and his book on "Backward and Feeble-Minded Children" did valiant service in arousing interest in the care of these unfortunates.

During the holiday season, Professor M. V. O'Shea of the University of Wisconsin addressed a number of conventions of educational people and citizens on the Pacific coast. He lectured among other places at Los Angeles, Riverside, Pasadena, Santa Anna, San Francisco, Oakland, Salem, and Portland.

Dr. George R. M. Wells, instructor in psychology in Oberlin College, has been promoted to an associate professorship in that institution.

PUBLICATIONS RECEIVED.

(Notice in this section does not preclude a more extended review.)

Annual Report of the Superintendent of Schools, New Orleans, La. Session 1912-1913. Pp. 207.

Almost half of this excellent report is devoted to "Notes on the Problems of Extreme Individual Differences in Children of the Public Schools," by David Spence Hill, Ph.D., director of the department of educational research. Part I deals with "Ideals and Measurement of Results," Part II with "Individual Studies of Children," and part III with "Remedies Available and Proposed."

LEONARD P. AYRES. *The Effect of Promotion Rates on School Efficiency.* Reprinted from the American School Board Journal, May, 1913. Pp. 13.

Small differences in promotion rates are much more significant than is commonly supposed. "For each per cent that the promotion rate falls, there are seventy more failures among each 1000 children in eight years of schooling. The annual promotion system tends to carry more children through the course on schedule time than does the semi-annual system, but it leaves more of them seriously retarded.

JAMES MARK BALDWIN. *History of Psychology. A Sketch and an Interpretation. Vol. I. From the Earliest Times to John Locke.* Pp. xiii, 168. $0.75 net. *Vol. II. From John Locke to the Present Time.* Pp. vii, 214. $0.75 net. New York: G. P. Putnam's Sons, 1913.

This noteworthy addition to the "History of the Sciences Series" will be especially welcome to English speaking students of psychology who desire to reach an adequate understanding of the setting of their science in the mosaic of human thought. The work is superior to the German books in this field in that it brings the subject up to date, and takes account of the recent movements in genetic psychology.

WILLIAM BATESON. *Problems of Genetics.* New Haven: Yale University Press, 1913. Pp. ix, 258. $4.00 net.

This excellent survey of recent studies in genetics is a revision and amplification of the Silliman Lectures delivered at Yale University in 1907. The author is much less sanguine in the promulgation of biological theories than earlier writers, and insists that we know too little about life processes to make our theories more than mere guesses.

CLOUDESLEY, BRERETON. *Studies in Foreign Education with Special Reference to English Problems.* Boston: Houghton Mifflin Company, 1913. Pp. xii, 290. $1.60 net.

A valuable collection of papers on educational problems in England, France, and Germany. The author is especially familiar with French conditions, and is disposed to think that England can find much in French educational procedure that would be of profit in her own educational reorganization.

J. B. BURY. *A History of Freedom of Thought.* New York: Henry Holt & Co., 1913. Pp. v, 256. 50c. net.

A fascinating account of the long struggle between human reason and blind acceptance of authority as the controlling factor in conduct. The author emphasizes the important duty of education to secure to the youth the proper historical perspective for the appreciation of the value of freedom, and to break away from the traditional reverence for authority in the educative process itself.

C. WARD CRAMPTON. *The Significance of Physiological Age in Education.* Reprinted from the Transactions of the Fifteenth International Congress on Hygiene and Demography. Washington: Government Printing Office, 1913. Pp. 13.

A clear and cogent argument for the separation of children on the basis of physiological rather than chronological age. Some of the advantages of this policy are summarized by the author: (1) Boys in a homogeneous class feel more at home, and form for themselves a coherent group consciousness. (2) Consistent methods of management and discipline may be applied to the whole class. (3) Choice of subject-matter may be made appropriate to all. (4) Teaching methods and manner of appeal may be adapted to group needs.

VINCENT D'INDY. *Beethoven: A Critical Biography.* Boston: The Boston Music Co., 1913. Pp. 127.

A vivid and intimate portrait of the great German composer by one of the leaders of the modern French school. Perhaps the most valuable portion of the book is the last chapter, in which the more important works of the master are subjected to a critical analysis by the modernist.

J. D. EGGLESTON AND ROBERT W. BRUÈRE. *The Work of the Rural School.* New York: Harper and Brothers, 1913. Pp. ix, 287. $1.00.

A systematic, constructive policy for the reorganization of rural schools. The book is full of interesting suggestions for increasing the efficiency of the country school.

WILLIAM SCOTT FERGUSON. *Greek Imperialism.* Boston: Houghton Mifflin Company, 1913. Pp. xiv, 258. $2.00 net.

An account of the transformation of the Greek city-states from ultimate units to constituent parts of larger wholes. A valuable supplementary book for the teacher of ancient history.

DOROTHY CANFIELD FISHER. *The Montessori Manual for Mothers and Teachers.* Chicago: The W. E. Richardson Co., 1913. Pp. 126. $1.25 net.

A popular statement of the basic principles of Madam Montessori's doctrine, as applied to American conditions. The book contains many illustrations of the Montessori didactic apparatus, and of children using it.

J. P. GARBER. *Current Activities and Influences in Education.* Philadelphia: The J. B. Lippincott Co., 1913. Pp. 370. $1.25.

A lucid and interesting account of the manifold changes in educational outlook in this country and Europe. A valuable reference book for teachers and students who wish to keep in touch with current educational events.

JULIA CLARK HALLAM. *Studies in Child Development. A Manual for Mothers and Mothers' Clubs.* Chicago: Row, Peterson & Co., 1913. Pp. 285.

An attempt to set forth in popular form the results of modern studies in child development. The material is treated under the following rubrics: Infancy, childhood (from two to seven), youth (from seven to twelve), and the adolescent boy and girl.

PAUL H. HANUS. *School Efficiency. A Constructive Study.* Yonkers-on-Hudson: World Book Co., 1913. Pp. xxix, 128.

A concise summary of the conclusions reached by the investigators in the New York City School Inquiry, and an application of these fundamental principles to the problems of education in general.

HARRY L. HOLLINGWORTH. *Advertising and Selling. Principles of Appeal and Response.* New York: D. Appleton & Co., 1913. Pp. xiii, 314. $2.00 net.

This book, prepared for the Advertising Men's League of New York City, presents the results of experimental psychology that are of importance for advertising. The book is written in simple, untechnical language, yet is thoroughly scientific in its treatment.

TIGHE HOPKINS. *Wards of the State: An Unofficial View of Prison and the Prisoner.* Boston: Little, Brown & Co., 1913. Pp. viii, 340.

To what extent and in what manner can the anti-social individual, the criminal, be educated to make him a less troublesome and more efficient member of society? This is one of the important problems of our time, and the present book is an eloquent appeal for intensive study of it. The author shows that our present methods of treating prisoners, while vastly superior to those of a century ago, are still a rank failure so far as the accomplishment of the desired end is concerned.

E. G. LUTZ. *Drawing Made Easy.* Weehawken, N. J.: Published by the author, 1912. Nine plates. 25 cents.

E. G. LUTZ. *What to Draw and How to Draw it.* Weehawken, N. J.: Published by the author, 1913. Pp. 78. $1.00 net.

Drawing is a form of expression, and as such ought to be at the command of every educated person, just as reading and writing. The author has devised a system of teaching the elements of drawing that has for children all the attractiveness of play.

JOHN MACCUNN. *The Making of Character. Some Educational Aspects of Ethics.* Revised and rewritten with new chapters. New York: The Macmillan Company, 1913. Pp. ix, 262. $1.25.

The author recognizes the factors of original nature that enter into character formation, but emphasizes the fact that as yet we know too little about the laws of heredity to be able to predict the outcome of a given environment in its effects upon a given individual. Hence in our training we must be guided by moral and social ideals. The book, which has had a useful and honorable history, will be found much strengthened in the new edition.

JOHN SAYRE MARSHALL. *Mouth Hygiene.* Philadelphia: The J. B. Lippincott Co., 1912. Pp. xi, 262. $1.50 net.

The recent statistical and experimental studies on the mouth conditions of school children, and the effect of remedial treatment upon general health and upon school standing make the present work very opportune. The concluding chapter gives an account of recent oral hygiene propaganda. The value of the book would have been increased if more attention had been paid to the establishment of dental clinics in this and European countries.

THOMAS HUNT MORGAN. *Heredity and Sex.* New York: Columbia University Press, 1913. Pp. ix, 282. $1.75 net.

An admirable survey of recent experimental investigations on sex determination, Mendelian principles, secondary sexual characters, fertility, and sex-inheritance. There are one hundred and twenty-five splendid figures, and twenty-eight pages of bibliography.

THOMAS SPEED MOSBY. *Crime, its Causes and Cures.* St. Louis: C. V. Mosby Co., 1913. Pp. x, 354.

A study from the legal point of view of the causes of crime, the means for its prevention, and the best methods of treating the criminal. The factors making for prevention are eugenics, asexualization, education, and social amelioration. Like most modern writers on the subject the author considers the criminal a social misfit, and thinks that it is the duty of society not to punish him, but to secure adjustment or to provide restraint for him.

J. P. MUNROE. *The Business Man and the High School Graduate.* Reprinted from Popular Science Monthly, July, 1913. Pp. 8.

"Secondary schools cannot, of course, make silk purses out of sows' ears; but they can make it their chief business to deliver to the business world boys and girls whose bodies, senses, and minds have had so much organized training as heaven has permitted them to receive; who have passed out of the stage of 'kids' into that of men and women; who have a conception of and experience in co-operation and team-play; who know what loyalty means; and who have taken school work so seriously that they are prepared to look upon the earning of one's daily bread as something other than a listless game."

ROSE O'NEILL. *The Kewpies, Their Book.* New York: Frederick A. Stokes and Co., 1913. Pp. viii, 80. $1.25 net.

There is no more fascinating book for young children (and for many grown-ups too) than this profusely illustrated volume from the pen of Rose O'Neill. The Kewpies have quite supplanted the Brownies in their bid for popular favor, and their vogue promises to exceed that once enjoyed by their former rivals. There are psychological reasons for this, and not the least important of these are the plump kindliness and rollicking good cheer which beam forth upon the reader from the Kewpies' chubby, infantile faces.

EUGENE OSTY. *Lucidite et intuition. Etude experimentale.* Paris: Librairie Felix Alcan, 1913. Pp. xxxix, 477. Fr. 8.

This imposing volume represents an attempt to show by detailed studies of actual cases that there is a modality of human thought

which does not depend wholly upon the senses or upon intellectual processes, but upon what the author calls "intuition." Individuals endowed with this "faculty" are not limited by the ordinary barriers of time and space, but "are like mirrors in which is reflected the intuitive thought latent in each one of us."

WILLIAM HENRY PYLE. *The Examination of School Children. A Manual of Directions and Norms.* New York: The Macmillan Company, 1913. Pp. 70. $0.50.

This little book selects eight mental and seven physical tests from Whipple's *Manual of Mental and Physical Tests,* gives simple and explicit directions for their use in the school room, and presents norms from a considerable number of school children in each grade. The tests are as follows: Mental,—logical memory, rote memory, substitution, uncontrolled and controlled association, cancellation, imagination, and invention. Physical,—height, weight, grip, tapping, vital capacity, vision, and hearing.

CONWAY WHITTLE SAMS. *Shall Women Vote? A Book for Men.* New York: The Neale Publishing Co., 1913. Pp. 345. $1.35 net.

It is difficult to say whether this book is the more ridiculous in its absurdity or pitiful in its weakness. Certainly, if this were a fair sample of masculine logic, it were better that the men be disfranchised and that the government be turned over to the women. There is much quotation from the Bible, from history, and from newspaper reports of law court procedings.

SAMUEL C. SCHMUCKER. *The Meaning of Evolution.* New York: The Macmillan Company, 1913. Pp. 298. $1.25.

All of our modern scientific thinking is founded upon the conception of evolution, yet few of the children in our schools have any but the vaguest ideas about the history and real significance of the doctrine. It is on this account that we need simple, popular statements of the theory, such as that admirably set forth in the present book.

CARL EMIL SEASHORE. *Psychology in Daily Life.* New York: D. Appleton & Co., 1913. Pp. xviii, 226. $1.50 net.

Reverting to the nomenclature of an earlier day, one might well call this delightful book "The Recreations of a Psychologist." For here we find developed with a light but sure hand attractive by-products of psychological study which cannot fail to interest the lay reader, while at the same time they illustrate and reinforce important psychological principles. The book offers an abundance of material for enlivening an introductory course in psychology.

FLORA ANNIE STEEL. *The Adventures of Akbar.* New York: Frederick A. Stokes Co., 1913. Pp. 204. $1.35 net.

A charming story of Asiatic life, dealing with the fortunes of little Prince Akbar, who afterward became Akbar the Great, Mogul of the Indian Empire in the sixteenth century. The author is well known for her novels of Indian life, and has here produced a delightful tale for children.

WILLIAM STERN. *Die Anwendung der Psychoanalyse auf Kindheit und Jugend. Ein Protest.* Reprinted from Zeitschrift für angewandte Psychologie. Bd. 8, Heft 1 & 2, 1913. Pp. 33.

A vigorous and well justified protest against the absurd extremes of the psychoanalysts in attributing sex motives to young children. With the highly organized sex symbolism which is assumed at the outset, it is not difficult to interpret the simplest and most casual behavior of the child as symptomatic of sex tendencies. Thereby the grossest injury may be done the child in forcing upon his attention sexual interpretations of conduct which would otherwise never occur to him.

Syllabus of Home Economics. Prepared for the American Home Economics Association by its Committee on Nomenclature and Syllabus. Baltimore: American Home Economics Association, 1913. Pp. 69.

"The purpose of this syllabus is to classify in logical order the various topics which can properly be included under the term 'Home Economics.' It does not represent an outline for a course of instruction, but rather a classified list of topics from which courses can be made up."

IVAN WICKMAN. *Acute Poliomyelitis (Infantile Paralysis).* Translation by J. Wm. J. A. M. Maloney. New York: Jour. of Ner. and Men. Dis. Pub. Co., 1913. Pp. 134. $3.00.

A simple and direct statement of the nature of the disease and its diagnosis, prognosis, epidemiology, and treatment.